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EDITED BY

LIONEL S. BEALE, M.B., F.R.S.

VOL. III.

With Original Papers and Memoirs.

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W. STRANGE, M.D.

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AND COMMUNICATIONS FROM OTHER CONTRIBUTORS.

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MEDICINE:

A RECORD OF PRACTICAL OBSERVATIONS AND ANATOMICAL AND CHEMICAL RESEARCHES CONNECTED WITH THE INVESTIGATION AND TREATMENT OF DISEASE.

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BY

J. Adamson, M.D.
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OF

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PLATE I.

CLINICAL OBSERVATIONS, BY DR. GAIRDNER.

AS the interest of the case recorded in this paper depends, to a very great extent, on particulars falling within the observation of Mr. J. Lockhart Clarke, to whom a portion of the nervous centres was transmitted, and who has, in the interest of science, kindly undertaken to publish the results of his observations, I think I shall best fulfil my part by simply prefixing a notice of the leading phenomena observed during life and after death; leaving the anatomical and physiological discussion of the facts in the hands of those more competent to do justice to them. And as the case was one of more than usual importance, it may be well to explain that my connection with it consists chiefly in having seen the patient at intervals, in consultation with

Drs. Adamson and Bell, of St. Andrews, to whom I owe the concise narrative of the history introduced into the present record. At one time, indeed, the patient was under my care for a period of a good many weeks, during which he resided in Edinburgh; but from his frequent changes of residence, and consequently of medical superintendence, it is difficult or impossible to furnish a continuous narrative of the facts in detail; and hence the somewhat desultory form of this paper, which will however, I trust, be found to subserve, in some degree, the purposes of the physiologist and of the practical physician. The patient was seen, at different times, by the following physicians, among others: Dr. Day, of St. Andrews, who took a very constant interest in his case from first to last; Drs. Christison, Simpson, Begbie, and myself, in Edinburgh; Dr. Andrew Anderson, in Glasgow; Drs. Todd, Burrows, Copland, and Gull, in London, and Dr. Robertson, of Brixton; at a later period by a considerable number of foreign physicians, and last of all, by Dr. Brown-Sèquard, on his visit to Scotland in 1859. As several of these gentlemen were much interested in the case, I would suggest that a copy, in proof, of this record should be transmitted to each of them, in order that any supplementary facts may be duly embodied in the publication, either by communication with me, or by a separate statement transmitted to the Editor, who will, I trust, assume the responsibility of doing justice to these communications, in as far as consistent with the objects of his Journal.

The following is the narrative of Drs. Adamson and Bell, with some slight additions as to the treatment, derived from my personal knowledge.

"Dr. P.——, aged 65 years, small in stature, of sanguine temperament, florid complexion, and full habit, leading a temperate and sedentary life, and engaged in literary occupations, in the end of 1855 began to complain of neuralgic pains in the ball of the thumbs of both hands, which before long extended to the forearms and arms. After some months he was conscious of marked weakness in the hands, more especially in the right, soon followed by perceptible diminution of size in the muscles of the thumbs and index fingers, which also became bent inwards and towards the palms, as an habitual posture. In the summer of 1857, this habitual flexure of the thumbs occasioned manifest deformity of the hands, which themselves became flexed towards the wrists, with a constant tendency to assume the prone position. His difficulty in using the hands, especially the right, was most apparent when in the act of taking food, or

when raising a glass to his mouth. When extending the forearms also, the deformity was very visible, as the flexion and pronation of the hands were then fully seen. The position of the hands and fingers, at once conveyed to medical observers the impression of the "drop't wrist," resulting in cases of paralysis from "lead poisoning;" so much so, indeed, as to have led to a careful examination on this point, but without any trace of such a cause for his symptoms being discovered. All this time, while his general health was good, and his body corpulent, he made great complaint of severe neuralgic pains shooting down his arms into the hands and thumbs, and also of weakness of the back; and considering himself a great invalid, he consulted many doctors, and went to various watering places and spas in succession, in Scotland, England, and Germany. Nothing abnormal could be detected in the organs of the chest or abdomen. The kidneys and bowels acted regularly, and apparently naturally—he had no tenderness of the spine, no headaches, and his mind, when not turned upon his own condition, was clear and rational. The only occasion on which anything like head-symptoms occurred, was in the end of 1856, at which time, on opening his class in the University, as was usual, with prayer, he became so confused while repeating the "Lord's Prayer," as to have to stop entirely, and appeared as if about to take some sort of fit. This passed off without bad effect or any recurrence.

"The further history of Dr. P——'s case, up to the time of his death (in January, 1861), which was preceded for a few days, and possibly actually caused, by an attack of "acute laryngitis," is nothing more than a detail of the gradual increase in the intensity of the symptoms already noted, and the extension of the pains to the lower limbs and feet, where the sensation of "intense heat and burning" was constantly complained of, aggravated by the act of walking. The pains were also referred to the trunk and breast, while the acts of mastication and deglutition, and even the process of shaving, were complained of as agonizing. These did not, however, interfere with his partaking of hearty meals. Within the last year or two there was a gradual falling-off in strength and general health, with an equally gradual and regular increase in the rapidity of the pulse, which from 65 (his natural pulse at the beginning of his illness), had risen to 100 and upwards towards the end of his last year. The respiration was not proportionally affected.

"His own description of the pain he endured in his arms and hands, as well as throughout the body, became in the same degree more and more intense, until language failed him to

express the "torture and agony" he was enduring, and his whole mind seemed engaged in the realization of his sufferings. He could not be prevailed upon to take either walking or carriage exercise, and for many months before his death was unable to feed himself, or use his hands in any serviceable way.

"His body, at the post-mortem examination, was found loaded with fat. There was a marked decrease in the size of his arms and forearms, and the muscles of the balls of the thumbs and index fingers were much atrophied, and of a pale fawn-colour. The position of the thumbs, and the general flexure of the fingers and wrist, so marked during life, continued in the same degree after death, and is, in some degree represented in a drawing.

Left arm and hand in the case of Dr. P., sketched from the dead body. The body was lying on its face, both forearms in the position of extreme pronation, which had become habitual; the hand and fingers inclined towards the ulnar side, and the fingers were always more or less bent towards the palm. The ball of the thumb was much atrophied, the flexor muscles of thumb pale and deficient in striated fibre, but not to any great extent in a state of fatty degeneration. The muscles of the forearm generally were small and rather flaccid, but their colour was well preserved. There was no very apparent difference between the flexors and extensors.

"As respects treatment, it may be mentioned that he made a long continued trial of the following remedies, viz.—Iodide of potassium with sarsaparilla, strychnine, quinine, valerianate of zinc, phosphate of zinc, arsenic, tinctures of lobelia and lupulus, of cantharides, ergot of rye, actea racemosa, with various mineral acids. Throughout the progress of the disease, he employed occasional, and for the last two years regular, laxatives of colocynth and henbane, varied by the more active preparations of scammony and calomel. He had sedatives in every variety of form, externally and internally, and for the last three years, took Battley's sedative solution regularly every night, consuming about ℥xxx each year, besides trying chlorodyne, chloric ether, conium, henbane, lupulin, &c., &c. He tried galvanism and regular friction, or shampooing of the limbs, wet bandages, &c., &c. Subcutaneous injection of mor-

phia was repeatedly tried when pain was concentrated in any individual spot.

"Among other systems of treatment, he made a lengthened trial of the waters at Aix-la-Chapelle, and visited also several other German baths, including a water-cure establishment; he also placed himself, for a time, under a quack-doctor, whose grand specific was systematic friction and kneading of the spine. These plans of treatment he discontinued only on being thoroughly convinced that they did him no good.

"Counter irritation along the spine was also had recourse to, but each and all without the experience of any, even temporary, relief. The diet was always generous, and with a liberal allowance of stimulants."

Thus far Dr. Adamson and Bell's narrative. When I first saw Dr. P. in the end of October, 1856, the leading symptom was, as it continued to be to the last, the loss of power and of volume in the muscles of the hand and forearm; particularly in those of the ball of the thumb, which were as completely atrophied as in a pretty aggravated case of lead palsy; while, even at this time, the relaxation of the extensors of the forearm, and the peculiar attitude of the upper extremities, recalled that form of disease so strongly, as to suggest to all who had seen the patient medically the necessity of careful inquiries as to the possibility of metallic poisoning of any kind. There was, however, an entire absence of cachectic appearance; there never had been anything resembling colic, and the bowels, though sometimes requiring medicine, could not be said to be constipated to any great degree; the blue line on the gums could not be discovered; and the facts as regards residence, occupation, water-supply, &c., were such as to afford, in the opinion of his local medical advisers, no reasonable ground for suspicion of the presence in the system of lead, or of any other known poison. I believe, however, that the patient, at various periods before and after consulting me took iodide of potassium, with a view to the bare possibility of the existence of lead poisoning: and, on the advice of two very distinguished physicians who adopted that theory of his case, he afterwards went to Aix-la-Chapelle to drink the waters for a time, with no more benefit than from other modes of treatment. I lay no stress upon the fact that "a trace" of lead was alleged to have been found in the urine by an analytical chemist in London. If present at all, it must have been due to some accidental and temporary cause in London; for immediately on the return of Dr. P. to Scotland, the analysis was

repeated with the greatest care by the late Professor George Wilson (at the instance of Dr. Day), and without any result, not even the most infinitesimal "trace" of lead being obtained from a large quantity of the urine.

Setting aside the theory of lead poisoning, the disease which appeared most closely to resemble that of Dr. P. at the time I first saw him, was the form of palsy described by Cruveilhier, Aran, and others, as the "Paralysie musculaire atrophique," or "Atrophie musculaire progressive." The chief points of resemblance were the wasting of particular groups of muscles; the symmetrical character of the disease; the preservation of the tactile sensibility, whether tested by the sensations of the patient, or by the method of Weber; and the absence of any central paralysis, or, indeed, of any except the most vague indications of disorder (even functional) of the brain and spinal cord. I remember distinctly, indeed, that the patient at this time complained of some degree of difficulty in walking, as well as of pain in the lower limbs (which had been a very early symptom); and also of a liability to trip in going down a stair (it must be mentioned that there was ice on the ground at the time); but after careful examination, I found it impossible to determine how far these symptoms were real and positive, and how far they depended upon the intense exaggeration and nervous irritability which appeared to pervade his entire narrative of his own sufferings. To the last, although the patient became very inactive and unwilling to walk, there was no distinct indication of paraplegia, either in his gait, or in his power of retaining his balance in the upright posture.

Considered as an instance of Cruveilhier's paralysis, Dr. P.'s case always appeared to me to present an unusual amount, and a very remarkable persistency, of *pain* as one of its phenomena. From the summary of cases of this disease, given in the late excellent work of Dr. Roberts* of Manchester, it will be seen that pain, in greater or less degree, was present in about one-half of the cases recorded; but in most of them it was transient, extending over a few weeks, or, at most, months, usually at the beginning of the disease. It is certainly very remarkable, that in no one of Cruveilhier's four cases, though so elaborately recorded and observed over a long period, was there any pain; and the same entire absence of pain characterises all

* An Essay on Wasting Palsy. (Cruveilhier's Atrophy.) By William Roberts, B.A., M.D., Lond., &c. London, 1858. A remarkably complete and valuable memoir, which was very carefully considered by me in connection with Dr. P.'s case, and enables me to express the opinions here maintained as having been duly weighed during the life of the patient.

the cases of Dr. Meryon, in the 35th vol. of the Medico-Chirurgical Transactions, and also those of M. Duchenne, recorded at length in his work on Localized Electricity. In several of Aran's cases, on the contrary, pain was observed to a greater or less extent, and, what is remarkable, quite as often in other parts of the body as in those immediately affected with muscular wasting. The disease, in fact, as described by Aran and others, would appear to have been in some instances founded on a more or less general neuralgic or rheumatic tendency.

In one of the cases recorded by Romberg, there were pains in the back of the neck and face, the muscular disease having first affected the tongue, and then advanced to the muscles of deglutition and respiration; in another, there was neuralgia of the *opposite* arm to the one affected with paralysis; and in the affected arm, pains preceding the paralysis by about a year. In one or two cases, the pains were chiefly in the lower limbs, and the paralysis in the upper. Besides these, cases have been recorded which were obviously complicated with cerebral disease. On the whole, it may reasonably be doubted whether Dr. P.'s case was really of the same pathological character as those recorded by Cruveilhier himself; but then it must also be admitted, that many cases referred by authors to the type of progressive muscular atrophy have equally little right to that designation, considered as indicating a specific form of disease. Without entering here upon a general discussion of this subject, I think we must, in the meantime, at least, hesitate to admit that a disease, which differs so much in particular cases, is fairly to be included under a single physiological form; especially when its pathology is as yet so entirely undetermined, that even in the opinion of the authorities to whom we chiefly owe its description, it is quite uncertain whether the muscles or the nerves are the starting-point of the affection. I rather incline to the view, that under the name of "paralysie musculaire atrophique," as under the English title of "wasting palsy," employed by Dr. Roberts, several distinct diseases have probably been confounded together; and to some of these the case of Dr. P. certainly presents many points of resemblance. It is to be observed, that neither the excessive sensitiveness to low temperatures, nor the muscular vibrations observed in many of M. Duchenne's cases and others, were present in Dr. P.'s The sensibility of the affected muscles to the galvanic stimulus was decidedly and, I think, progressively impaired, but hardly at any time altogether lost.

The advance of the disease was attended, in the case of Dr. P., by an almost childish degree of helplessness, and a truly

pitiable state of mental irritability and hypochondriac depression. Day after day he would describe to every visitor, in succession, and always in language of the most intense kind, the sufferings he was enduring; over and over again I have heard him express his conviction that it was impossible for him to survive many more days of pain, while all the time his complexion, his pulse, his respiration, and the general muscular development of an originally robust frame, continued to indicate no serious diminution in the activity of the functions, with the exception of those mentioned as directly involved in the disease. Even up to a late period his appetite continued good, and his colour florid, while the tendency to take on fat was never checked, and may, indeed, have been increased by his extremely inactive habits. It was for a long time with the utmost difficulty (and latterly not at all) that he could be got to take exercise, whether on foot or in a carriage. The pain was not at all distinctly localized, nor accompanied by tenderness or pressure; and although he always spoke as if it was much aggravated by continued movement, whether active or passive, he never appeared to suffer acutely in any particular point, or under any particular kind of movement more than another. He always insisted on retiring very early to bed, giving as a reason, that his "torture" was a little less when in the recumbent position; and as he always rose late, it often happened that he would only be in his sitting-room for a few hours in the afternoon. To whatever extent he was occupied, it was with books; but at times his own sufferings monopolized his attention completely, and he declared that he could not read even a newspaper. Even at these times, however, it was not difficult to engage him in conversation; and when under excitement, he would display considerable activity, both of mind and body. His craving for sympathy was excessive, and it was difficult to resist a feeling of something ludicrous in his oft-repeated declarations, that "no mortal could conceive" how much he suffered; that every day he was "a thousand times worse" than before; and that he was sure "it must very soon come to an end now," as "no man could bear this" for many days longer, and live. I am sure I have heard all these expressions, or others like them, used over and over again up to hundreds of times, in the course of a few weeks during which he was under my observation in Edinburgh.

With all this loss of self-control and mental energy, there was no delirium, no disorder of the senses, no inconsequence of reasoning, no delusion (unless his pain was a delusion); his sight was good for his years; his hearing was unimpaired: his

articulation perfect; his memory seemed to be good; and, except that his constant preoccupation with his sufferings prevented the right use of his mental powers, the intellectual and moral faculties were wonderfully little affected by his disease. There was never any headache, dizziness, numbness, or impaired sensibility; no disorder of the special senses; never anything approaching to coma or convulsion (with a doubtful exception, mentioned above, in November, 1856); there was no paralysis of the articulation, or of the voice, or of respiration; and, in general, the voluntary movements, with the exception of those of the specially affected groups of muscles, as described by Drs. Bell and Adamson, were normal. The sphincters, indeed, seemed now and then to be not quite under control, for he sometimes (though not often, nor in the later periods of the disease,) passed his urine in bed; but he himself described this accident as owing entirely to his difficulty of getting out of bed in the dark, and not being able, accordingly, to get relief otherwise.*

From a very early period in the history of the case (certainly from the end of 1856), there was a very distinct difference in the size of the pupils; the right being constantly larger, by perhaps one-third, than the left. Neither pupil, however, could be said to be decidedly beyond the range of physiological difference; and it was very difficult to determine anything positively abnormal in the movements of either, considered apart from the other. Probably the state of the third pair of nerves, as recorded below, may account for this difference of the pupils. There was no corresponding difference in the distinctness of vision in the two eyes. The only case noticed in Dr. Roberts's list, in which there is any allusion to the state of the pupils, is one by Schneevogt, in the "Nederlandsche Lancet, 1854 (quoted from Schmidt's "Jahrbücher," 1855). In this case there was undoubtedly disease of the spinal cord, and the symptoms were more indicative of disorder of the nervous centres than in the case of Dr. P. After a gradual palsy of the right thumb, and of both forearms, "the speech became indistinct, and afterwards the gait became uncertain. This gradually increased to palsy of the lower limbs, without apparent atrophy. Mention is made of involuntary discharge of urine. The disease finally reached the respiratory muscles.

* I am not quite certain whether the power of deglutition can be said to have been perfectly preserved during the latter stages of the illness. The frequent complaints of pain and difficulty in the very act of eating raise a suspicion on this point, which is further increased by the suddenness of his death (not completely explained by the laryngeal symptoms). But after repeated examination into this point during life, both Dr. Adamson and I failed to obtain evidence of any real paralysis of the muscles of deglutition.

A tightness of the chest was a very early symptom." I shall have occasion to refer again to this case in speaking of the post-mortem appearances in several others in which the Cord was examined.

POST-MORTEM EXAMINATION, BY MR. BAYLDON.

In Dr. P's. case the post-mortem examination was performed with great care by my friend Mr. Bayldon, who was kind enough to accompany me to St. Andrews for the purpose; and who completed, in the presence of Drs. Adamson and Bell, a very careful scrutiny of all the cavities and more important organs of the body, which occupied a good many hours, and which I was, therefore, obliged to leave before it was quite finished. Mr. Bayldon's great experience in post-mortem examinations, no less than his general accuracy and distinguished success as a student of this school, in which he is now a valued teacher (having carried off the highest scientific honours at the University of London), induce me to place the most entire reliance upon his observations in those parts of the proceedings which I was unable to witness. The general result, as regards the organs of the thorax and abdomen, was that there was no appreciable amount of disease. The larynx alone presented anything which could be supposed to account for the difficulty of respiration experienced in the last few days of life. The appearances there were those of distinct, though very slight, *œdema glottidis*, with considerable congestion of the mucous membrane extending towards the trachea.

The arteries generally were slightly atheromatous, and the appearances of the body were those usual in moderately advanced age, the fat being in considerable volume both in the thoracic and abdominal parietes, as well as in the mesentery and omentum.

The brain, examined in every part with the utmost care, appeared strictly normal as regards both the grey and white matter. The arteries at the base, however, were considerably atheromatous: and the arachnoid from the olfactory nerves backwards to commencement of the medulla oblongata, and also in the fissure of sylvius, and about the inferior vermiform process of the cerebellum, presented distinct, though slight, opacity, with perhaps very slightly increased toughness. The opacity scarcely exceeded what is so commonly described as "milkiness," and regarded as of little or no account; but after due consideration of its distribution and amount, and especially of its predominance at the base, and its almost entire absence on

the upper part of the hemispheres and in the neighbourhood of the Pacchionian bodies, I am disposed to think that it must be regarded, in Dr. P's. case, as a more than commonly morbid phenomenon. The opacity was hardly traceable beyond the pons varolii, and not at all down upon the cord.

The nerves at the base of the brain were normal, with the following minutely and carefully ascertained exceptions :—The third pair (which was near the centre of the opaque portion of the arachnoid) differed in size on the two sides; the right nerve having a diameter of 0·08 inches, and the left 0·12 inches. To the eye the right third nerve appeared distinctly too small, and duller in colour than the left. After twenty-four hours' preservation in chromic acid, portions of each nerve were separately examined by Mr. Bayldon and myself, and also by Dr. Sanders, who was informed that the two nerves differed in size, but *not* which nerve was regarded as morbid: the general result of the three examinations being, that in the right nerve the ultimate fibres were denser and more granular than in the other to an appreciable extent; though not occupied by any distinct morbid deposit or otherwise decidedly abnormal. The left nerve of the sixth pair was a very little smaller than the right to the eye, but the difference could hardly be measured upon the scale.

The nerves arising from the medulla oblongata and spinal cord were generally examined as to their size and other characters, withont any positive result.

The cerebellum, pons varolii, and spinal cord were placed in a solution of chromic acid, grs. iij to ℥i of water, with the view of their being transmitted to Mr. Lockhart Clarke. The spinal cord was unfortunately injured at one point in being removed, but its consistence and external characters were not appreciably altered.

The sympathetic nerve in the neck was also examined, and found to be normal.

The state of the muscles in the hands and arms, is generally described in Drs. Bell and Adamson's narrative. Portions of the more atrophied muscles were examined microscopically, and proved to be at some points almost devoid of striæ; but although very slightly granular in the ultimate fibre, they were by no means in an advanced stage of fatty degeneration. The atrophy appeared, on the whole, to have been rather succeeded by the granular deposit than to have been its consequence, as supposed by Duchenne and other observers; and this conclusion, as respects the present case, is made more probable by the marked tendency to the accumulation of fat in the ordinary situations, rendering it unlikely that fatty matter, once deposited in the

muscles, would have been re-absorbed while the disease persisted.

I will only remark, in conclusion, in anticipation of Mr. Lockhart Clarke's observations, that in four cases only of the 105 included in Dr. Roberts's list was disease of the spinal cord detected. In one of these (No. 94), in which a very chronic loss of movement in the extremities was accompanied by phthisis and albuminuria, Virchow discovered amyloid degeneration of the posterior median columns, and a granular degeneration of the peripheral muscular branches; the anterior roots of the nerves were normal. In the three other cases there was softening of the cord in its lower cervical and upper dorsal portions, accompanied by granular corpuscles (as first described by Gluge) in both the white and grey substances. It is to be observed that in all of these cases there was much more extensive and general disturbance of the functions than in the case of Dr. P. In Virchow's case the paralysis in the end became general; there was besides albuminuria and phthisis. In Laboulbène's case (No. 95 in Roberts's list) there was very precarious health for years before the invasion of the special disease; and the symptoms are stated to have been those of myelitis (though without pain), ending in extensive muscular atrophy and disorder of the respiration. In the case by Schneevogt (No. 67), already referred to as being attended with contraction of the pupils, there was distinct paraplegia, preceded or followed by paralysis of articulation and respiration, with involuntary discharge of urine. In a case (No. 98), by Valentiner, the disease was ascribed to, or, at all events, shortly preceded by, a fall of eight or nine feet, with some local injury to the back; which, however, had not been followed by immediate bad consequences; the paralysis of the upper extremities became almost complete, and was followed by decided paraplegia, and marked paralysis of articulation and deglutition; there were great sensitiveness to lowering of the temperature, and remarkable variations in the frequency of the pulse. Death took place by bronchitis, but not until the patient had nearly lost the power of speaking and swallowing. It is probable that in this case, as perhaps in some of the others, the degeneration of the muscles was entirely a secondary phenomenon.

On the whole, therefore, the case of Dr. P. stands, in some respects, in a very different position from any case of so-called progressive muscular atrophy hitherto recorded, in which the examination of the spinal cord has been followed by positive results.

EXAMINATION OF THE CORD, &c., BY MR. LOCKHART CLARKE.

The cerebellum, pons Varolii, medulla oblongata, and spinal cord of the late Dr. P. were sent to me by Dr. Gairdner, of Edinburgh, with a request that I would examine them microscopically and ascertain whether they had undergone any morbid change of structure. On inquiry, I learned that these nervous centres had been removed two days and a-half after death; that they did not seem to be affected by any post-mortem changes; and that the body generally presented no appearance of putrefaction. Before I received them they had been placed in a weak solution of chromic acid, but not in spirit of wine. I at once examined them externally with great care. The third pair of cerebral nerves had been entirely removed. There was nothing remarkable in the appearance either of the pons Varolii or the cerebellum; but on separating the latter organ, the exposed floor of the fourth ventricle presented a peculiarity of aspect and structure which I shall describe further on. In the cervical enlargement of the spinal cord there was a deep, broad, and ragged wound, which had unfortunately been made in removing it from the vertebral column. This injury was rather more than half-an-inch in length, and had entirely destroyed the posterior white columns, with the whole of the posterior cornua or grey substance, as far forward as the central canal. The morbid change, which probably, as we shall presently see, existed at this part, rendered it, perhaps, more than usually liable to damage; and the fact should suggest the necessity of proceeding with the greatest care in removing the cord, whenever a lesion is suspected. With this exception, there was nothing unusual in the external aspect of the cord itself; neither were the anterior or posterior roots of its nerves, in any of the regions, smaller than usual to any appreciable extent.

Internal state of the cord. From the *filum terminale*, through the whole of the lumbar and dorsal region, to the lower end of the cervical enlargement, I found no actual change of structure, either in the white or grey substance; but still there was an unusual deposit which I shall describe further on. The structure was certainly rather more friable than in a perfectly fresh and healthy specimen; for when hardened in chromic acid, the elementary parts frequently separated under section; but not more readily, I think, than in healthy cords, especially of elderly persons, that have been kept a few days previously to immersion in chromic acid. In the cervical region, however, the case was different; for here there were decided evidences of morbid changes of structure in the posterior grey substance. These struc-

tural changes extended in a variable degree from the lower end of the cervical enlargement to the third cervical nerves. It is much to be regretted that the middle third of the cervical enlargement was accidentally destroyed, for it is probable that here the lesions were more extensive than elsewhere. They were also more conspicuous at its upper than its lower part. Figure 1 represents a transverse section of the right lateral half of the grey substance, with the transverse commissures and spinal canal, through the upper third of the cervical enlargement, magnified 17 diameters. But before I proceed to describe the *morbid* anatomy, it will be well, I think, to indicate the principal or most important points in the *normal* anatomy of the section; and with a view to both these ends, I have accurately drawn almost everything that could be seen under so low a power. A *a*, represents the *caput* cornu posterioris, or expanded extremity of the posterior cornu. In this region it is nearly conical in shape: the letter A is on a level with its base. The transparent lamina (*a*) surrounding the extremity of the *caput* cornu, is the *gelatinous substance*. It contains transverse, longitudinal, and oblique nerve-fibres, which are partly, at least, continuous with the posterior roots; some large nerve-cells, and a multitude of others that are small. The rest of the *caput* cornu is much darker, and consists chiefly of transverse, longitudinal and oblique nerve-fibres, collected into bundles of different sizes, the cut ends of which are represented in the figure, together with some large and small nerve-cells. The fibres are continuous with nerve-roots proceeding upward or downward from other parts of the cord. At the inner edge of the *caput* cornu, near the letter A, several of the bundles are nearly flat, so that in section they have a somewhat fusiform shape. The rest of the posterior cornu, from the base of the *caput* at A, to the posterior border of the transverse commissure, I call the *cervix* cornu.* In this region of the cord, nearly the whole inner half of the *cervix*, B, contains a number of nerve-cells of various shapes and small average size, constituting an important longitudinal tract, which I have called the *posterior vesicular column*. Amongst these cells, processes of which are prolonged longitudinally as well as transversely, many of the posterior

* The propriety of this anatomical subdivision of the posterior cornu into *caput* and *cervix* is indicated by the difference in structure of the parts so distinguished; while its convenience is here especially shown, by the facility which it affords of referring to particular parts of the posterior grey substance, and of indicating their exact relative position with clearness and precision. For further information on their structure, see my "Researches on the Intimate Structure of the Brain," first series, Phil. Transactions, 1858, and "Further Researches on the Grey Substance of the Spinal Cord," Ibid. 1859.

roots of the nerves are distributed in a complicated manner. On the opposite or outer side of the *cervix* are numerous bundles of longitudinal nerve-fibres, B′, of different shapes and sizes, and in close connection with a *network* of nerve-fibres and blood-vessels. These may be called the longitudinal bundles of the cervix. Their fibres are continuous on the one hand with some of the posterior nerve-roots, and on the other with longitudinal processes of some stellate or crescentic nerve-cells, by which they are partially embraced. The central canal, *f*, divides the posterior transverse commissure from the decussating fibres of the anterior commissure, at the front of which is the anterior fissure, *e*. The anterior grey substance or cornu, D, contains several separate groups of large nerve-cells, and several large, divided blood-vessels; C, C, are anterior or motor nerve-roots connected with it.* Now the section represented in this figure presented to the naked eye no appearance that would excite suspicion of any lesion whatever; for the morbid portions, although numerous, were small and isolated, and would probably have passed unobserved, had not the cord been hardened, and sections been subjected to some magnifying power. When this was accomplished by means of chromic acid, and very thin sections were carefully made with a sharp razor, the posterior grey substance, even under a low magnifying power, was seen to be interspersed with a number of unnaturally transparent streaks, patches, or spots, of different shapes and sizes. In fig. 1, one of these spaces, *m*, of an irregular shape, occupied almost the whole middle of the *cervix* cornu, from near the base of the *caput* cornu to the level of the central canal, *f*.† At its anterior extremity it included two blood-vessels, the cut ends of which are represented. On its inner side it was bounded by the column of cells, B,—the *posterior vesicular column;* and on its outer side, *posteriorly*, by the longitudinal bundles, B′, of the cervix cornu. Its middle portion, *m*, was dilated, and sent two processes outward, one of which reached a longitudinal bundle of the cervix. At the posterior extremity and inner side of the cervix was a small pyriform spot, *o*, which partly encroached on some of the longitudinal bundles of the caput cornu. Another morbid and larger spot *n*, was found at the side of the transverse portion of the grey substance, about midway between the anterior and posterior commissures, interrupting the course of certain nerve-

* For further information, see my "Researches," in Phil. Trans. 1859.

† To ensure perfect exactness with regard to the relative position, size, and shape of these morbid spaces, the outline of the entire section was taken by means of a *camera lucida*.

fibres which extended from both the anterior and posterior cornu to the opposite side. It enclosed the cut ends of two longitudinal blood-vessels; and I may here observe that in all the sections I examined, it was around, or at the side of blood-vessels, that the morbid appearances were most frequently found. Lastly, at *g*, on the opposite side of the central canal, *f*, and amongst fibres of the posterior transverse commissure, there was a small and somewhat triangular spot. The appearances here represented, although they differed in shape and relative position, may be considered as specimens of what were observed in other sections; and although in general they were more numerous and extensive on the right side, they were also apparent on the left, and in some sections, in an equal proportion. Fig. 2 represents a transverse section of the entire grey substance at the origin of the fourth pair of cervical nerves. The two lateral halves are seen to be unsymmetrical. This want of symmetry, however, was not the result of compression, or any kind of manipulation. *a*, is the caput cornu posterioris; *b*, the cervix cornu; *d*, the anterior cornu; *c*, the *tractus intermedio-lateralis*, or lateral part of the grey substance which projects from between the two cornua into the lateral white column; *e*, the anterior median fissure; *f*, the posterior median fissure. At *g*, are seen two morbid portions—the one heart-shaped and replacing a part both of the posterior commissure, and of the deepest stratum of the posterior white column, at the side of the posterior median fissure. The other lesion had the appearance of two oval cells placed end to end, nearly in the middle of the base of the cervix cornu. Between these and the former there were two small oval spots, lying amongst the fibres of the posterior commissure. On the opposite side of the grey substance, a somewhat triangular space, above the letter *h*, was found in the centre of the base of the cervix cornu; and another, of a circular shape, on the right of *h*, and at the base of the *tractus intermedio-lateralis*, *c*. We see, then, that the morbid spaces varied in shape, size, and relative position in different sections. In some they appeared as mere fissures or cracks, which, under a low power, might have been considered as the result of accident, if they had not been so uniformly found in only one portion of the grey substance, and more on one side than on the other. But when a sufficiently high power was employed, it became at once evident that they were not merely vacant spaces, but composed of a substance which differed entirely in its nature from that of the surrounding tissue. This substance had a delicate, transparent, and very finely granular aspect. The granules were more closely aggre-

gated toward the centre of the mass, but were generally so fine, that they could not be distinctly seen under a power magnifying much less than 400 diameters. Fig. 3 is an exact representation of one of these spots, found on the outer side of the cervix cornu, a little below the group of longitudinal bundles, (B′, fig. 1) and magnified 420 diameters. It was almost perfectly oval and abruptly circumscribed by the surrounding healthy tissue, from which, however, the broken ends of nerve-fibres that appeared to have originally traversed the space, projected into it to variable distances. In the centre there was, comparatively speaking, a large tubular vacant space or short canal, *i*, which extended longitudinally for a few lines in the grey substance. Its walls were rather even or smooth, and composed of a layer of granules which were larger and more closely aggregated than those nearer the circumference of the spot. This was the only instance in which I met with such a canal. Sometimes at the edges of these morbid spaces, there *seemed* to be a kind of transition or degeneration of the surrounding nerve-tissue into the granular substance of which they were composed, as represented in fig. 4. In some instances, the broken ends of nerve-fibres proceeding from the posterior roots, were seen to project into opposite sides of these spaces, across which there was strong reason to believe that they had once been continuous.

In ascending the cord, from the upper third of the cervical enlargement, the morbid appearances diminished in extent, generally, but not uniformly, and gradually disappeared about the level of the third pair of cervical nerves. In the lower third of the same enlargement, they were very like those in the upper, and disappeared on approaching the dorsal region. In the middle third, which was unfortunately nearly all destroyed by accident, they were in all probability more extensive than elsewhere.

But in addition to these actual lesions of the grey substance, there was another unusual condition that deserves especial notice, viz., a considerable deposit of *corpora amylacea.* These bodies were thickly accumulated around the central canal, and extended in smaller numbers through the whole of both the anterior and posterior commissures, but not beyond them. They varied both in size and appearance;—in size, from about that of a blood-disc, to the 1400th of an inch in diameter; and in appearance they were either clear and plain, or marked more or less distinctly with concentric lines. They were also found in the same locality,—that is, around the central canal,—throughout the whole of the *dorsal* and *lumbar* portions of the cord, but not in so large a number as in the *cervical* region.

The *anterior* grey substance presented no marks of disease. The only fact that requires notice, is, that the large multipolar nerve-cells contained an unusual abundance of dark-brown pigment-granules, which were often remarkably *coarse*, and accumulated sometimes at one end, sometimes through one-half of a cell; or distributed around the nucleus to a variable depth, and often filling the cells.

The *medulla oblongata* had suffered no actual lesion or morbid change of structure either in its grey or white substance, but, throughout its entire length, I found a large accumulation of *corpora amylacea* around the locality of the canal, and extending in smaller numbers amongst the decussating fibres of the anterior pyramids.

The whole floor of the fourth ventricle, as already remarked, presented a very peculiar and unnatural aspect. Instead of being smooth and shiny, as in the healthy state, it was entirely paved with a multitude of granulations or small rounded eminences, which were very closely aggregated, but differed from each other considerably in size. I removed some of them for examination, first by scraping them off from the surface, to which they adhered with some tenacity; and then by shaving off a section together with a thin layer of the subjacent tissue. When examined by means of a sufficiently high magnifying power, the granulations or eminences were seen to consist of globular aggregations of the ordinary epithelial-cells, which, in a natural or healthy state, are arranged side by side, and form a smooth or level surface on the floor of the ventricle. The tissue immediately subjacent, and which consists of exceedingly fine fibres proceeding from the tapering ends of the epithelial-cells, and running in various directions, was more abundant than usual; and,—as might be expected from the homologous relation of this part to that which surrounds the spinal canal,—they were interspersed with *corpora amylacea,* but certainly not to a corresponding extent.

There was also in this region one other condition, which, although I consider it, for the most part, as a post-mortem change, I think proper to mention. This was a softened state of the central part of the medulla beneath the fourth ventricle. It began gradually about the level of the auditory nerve, and extended beneath the aqueduct of Sylvius, through the pons Varolii to its anterior extremity. In the *middle* of the *pons,* it reached from a little behind the continuation of the anterior pyramids to within about the $\frac{1}{8}$th of an inch of the floor of the ventricle. Laterally, it extended from the inner side of one middle peduncle of the cerebellum to that of the other. This

softened mass, therefore, involved the following parts; 1°, the continuation, on each side, of the caput cornu posterioris, forming the principal nucleus of the large or sensory root of the trifacial nerve, together with the adjacent nucleus of its motor root; 2°, the transverse fibres which cross the middle of the pons Varolii, and proceed in front of the nuclei of the trifacial nerves on each side, where they join the middle peduncles of the cerebellum; 3°, the portio dura of the 7th, and the 6th nerves, which pass backward across the transverse fibres above mentioned to their nuclei at the floor of the fourth ventricle; and 4°, the locus niger and vesicular nuclei of the *third* cerebral nerves. My reasons for considering this state of softening as chiefly a post-mortem change, are the following: 1°. On examining different parts of the softened mass with a suitable magnifying power, I was unable to find any trace of morbid deposit, or appearance of degeneration. There was an entire absence of granular or exudation corpuscles, and no indication whatever that the softened condition was the result of inflammatory action.* It is true that the nerve-cells, although entire, were not so sharply defined as usual. Many of the nerve-*fibres*, also, were affected in the same way. The distinction between the white substance and the axis-cylinder was, in some instances, almost entirely lost; but then I have observed the same kind of softening, and similar appearances, in nervous centres that have been kept several days without preservation, but in which there has been no reason to suspect any disease whatever. Moreover, all the surrounding parts that had been exposed to the action of the chromic acid, were preserved from the softening process; but precisely in those particular parts where the chromic acid had no access, there was a corresponding degree of softening. Such was the case at the lower end of the fillet, and under the outer part of the superior peduncles of the cerebellum, which the chromic acid solution was unable to reach, until the cerebellum was removed. 2°. Considering the important parts which I have mentioned as involved in the softening process, if this process had been the result of any morbid action, we should expect to find in the history of the symptoms a corresponding number of grave lesions of the functions to which these parts are subservient. But this was by no means the case. There was no abolition of sensation or motion in the parts to which the trifacial nerves are distributed; neither was there any paralysis of the muscles of the face, which are supplied by the portio dura of the seventh pair; nor any loss of power over the external rectus muscle of

* Neither were there in the spinal cord any traces of exudation corpuscles.

the eye, as there would have been, had the sixth cerebral nerve been diseased. It is true that the third cerebral nerve, on the right side was found to be somewhat smaller than on the left, and that the right pupil was constantly dilated; but then the nuclei from which these nerves take their origin, were *both* softened to an equal degree, and to such an extent, that paralysis of the parts which they supply must have inevitably followed, if the softening had existed during life. Nevertheless, it is not at all improbable that there was some departure from the healthy state, and that had it been possible to harden the parts and make the necessary sections, I might have discovered certain morbid appearances similar to those which I detected in the spinal cord.*

With regard to the pathology of Dr. P's case, the wasting and loss of power in the muscles of the arms and hands must be considered, I think, to have originated, not in the muscles themselves, as a specific muscular disease, and as the consequence of some peculiar defect of nutrition, but in the spinal cord, as the result of some peculiar degeneration and softening of particular points of the grey substance. By the history of the case we learn that the loss of power and the pain *preceded* the wasting of the muscles; and that there was that muscular contraction, with flexure of the joints, which is frequent in softening of the nervous centres. The *upper* extremities *alone* were the parts affected; lesion of the cord was found only in the *cervical* region. *Both* upper extremities were involved in the disease, but the *right* was more so than the left; and on *both* sides there was lesion of the spinal cord, but most on the *right* side. Time and patient observation can alone enable us to determine whether the "paralysie musculaire atrophique" of Cruveilhier be really a specific disease of the muscular system, entirely independent of the condition of the spinal cord. There are many facts in favour of this opinion. But whether it be so or not, there is much probability, I think, that many cases which have been considered as examples of such disease, might be referable to some lesion of the spinal cord. I have little hesitation in declaring that if the cord in the case now under consideration had been examined in the way that cords have hitherto been examined, it would probably have been pronounced healthy, and that the disease would have been chronicled as a case of "paralysie mus-

* When once nerve-substance has become softened to a considerable extent by post-mortem changes, it ceases to harden by immersion in chromic acid. It may be well to state that my examination of the cord, &c., as above described, was made before I read the history of the case and the remarks by Drs. Bell, Adamson, and Gairdner.

culaire atrophique," accompanied with pain; for in some places the lesional spots, though numerous, were so small as to be quite imperceptible to the naked eye. Out of all the numerous cases recorded as Cruveilhier's disease, and collected together in the valuable and able Essay of Dr. Roberts of Manchester, in only 13 was the nervous system examined, and in 4 of these 13 some disease of the spinal cord was discovered.* There may be very obscure structural changes in the grey substance of the cord, or perhaps only in the ganglia on the posterior roots of the nerves, that may affect the nutrition of the parts to which they are subservient, without interfering with the functions either of sensation or motion; and in cases like the one now in question, where the lesions occur in small isolated spots, the limitation of disease to particular muscles, or even to particular fasciculi of any one muscle, could be explained, I think, by the particular distribution of separate nerve-fibrils within the grey substance. But when there is a prospect of deciding the question by experience and observation, it is useless to waste time in speculation.

As we have been prevented by accident from ascertaining the real condition of the most important part of the cervical enlargement,—that part, namely, which contains the greatest relative amount of grey substance, and gives origin to the greatest relative number of nerve-roots, it would not, I think, be prudent to attach much importance to any physiological conjectures that might be raised by this single case. It teaches us, however, that those particular parts of the cervix cornu, and of the transverse commissure, which had undergone degeneration, as represented in figs. 1 and 2, cannot be the centre of those changes which excite sensation in the sensorium, since there was no loss of sensibility. The violent pains experienced in the arms and hands would appear to have been excited centrally, by extension of morbid irritation to those parts of the grey substance which are subservient to the sensation of the affected muscles. Such a radiation of morbid irritation from the lesional spots to distant parts would appear to be the only explanation that can be given as a cause of the pains and sensation of "intense heat and burning" that were experienced in the lower limbs and feet; for, with the exception of the *corpora amylacea* around the central canal, there was no unnatural appearance of any part either of the grey or white substance in the lumbar region of the cord. Probably the same cause may account for the severe pains which accompanied the acts of mastication and deglutition, and even the process of

* "An Essay on Wasting Palsy." By Dr. William Roberts, p. 156, et seq.

shaving; although, as we have already seen, there may be some doubt whether the grey substance which gives origin to the trifacial nerves was entirely free from disease.*

Without dwelling any longer on this part of the subject, I will conclude with a few remarks on what my own experience suggests as the most successful method of investigating the morbid anatomy of the nervous centres. For it appears to me that if we are to arrive at strictly accurate and available results, in both a pathological and physiological point of view, the mode of inquiry must be more searching and exact than that which has hitherto been pursued.

It would scarcely be necessary to insist on the great importance of removing and examining the nervous centres as soon as possible after death, were it not that the practice is too often neglected. Great caution also should be exercised to avoid injuring the parts, so that when hardened, perfect or *entire* sections of them may be obtained for examination under the microscope. After they have been carefully examined externally, by the assistance of a lens if necessary, incisions should be made, not at random, but in a regular manner through them; and wherever there is reason to suspect the existence of disease, small portions should be removed, and examined while perfectly *fresh* under high magnifying powers. The *nature* of the lesion having been thus ascertained, the morbid parts, with some of the surrounding healthy tissue, should be removed, and after being divided, if necessary, into smaller portions, should be macerated in a weak solution of chromic acid. It is very important to cut and subdivide the parts, when necessary, in such a manner, that their relation to the rest may be recognized after they have become hardened for the purpose of making sections. In general, each inquirer must exercise his own judgment with this end in view; but for certain parts of the nervous centres some particular directions may be given. It is advisable, for instance, to divide the pons Varolii or the entire mesocephale, transversely by clean and smooth incisions made with a sharp and broad-bladed knife, into portions of about half-an-inch in thickness, and always on one side of the origin of the nerves. Thus,—unless the locality of the lesion require a different course,—one incision may be made through the crura cerebri, immediately in front of the third pair of cerebral nerves; another immediately in front of the small or motor root of the trifacial nerves; and a third

* I have shown, elsewhere, that the descending fibres of the *trifacial* nerve run down the *medulla oblongata* through the *caput cornu posterioris,* forming some of its longitudinal bundles.—Phil. Trans., 1858.

through the base of the anterior pyramids, immediately below the attachment of the sixth pair of cerebral nerves. With regard to the spinal cord, if it be cut up into small portions and hardened in chromic acid, those who are not thoroughly and practically acquainted with the exact shape and appearance of any section throughout its length, will find themselves somewhat embarrassed in endeavouring to identify each part, unless they adopt some means to assist them. Whenever it is unnecessary to cut the cord into a great number of pieces, it will be found better to divide it in three places: 1st, through the middle of the cervical enlargement; 2nd, through the middle of the dorsal region; and 3rd, through the middle of the lumbar enlargement. If, however, the lesion be suspected to exist at other points, the cord must be divided there; as it is highly important that the *nature* of any morbid portion that may be found, should be examined under the microscope in a *perfectly fresh* state; for the nerve-fibres, as I have elsewhere shown, undergo a considerable and very deceptive alteration by the action of chromic acid.* But it is no less important, and indeed is absolutely necessary for an exact and complete investigation, that *entire* portions of the cord, in the locality of the lesion, be hardened in chromic acid, so that thin, but *perfect* sections may be made for examination under the microscope. This plan affords the only means of ascertaining, as I have now done, and represented in figs. 1 and 2, the *exact form, size, and relative position* of the lesional parts—information which must be acknowledged as absolutely essential to a correct interpretation of the symptoms, both in a pathological and physiological point of view. In the present case, if the cord had not been injured at the part where in all probability the disease was most extensive, I should have made a sketch of the *exact form, size, and relative position* of every *different* morbid appearance that occurred in *different* sections; and such a plan ought to be adopted by all who desire to pursue their investigations with perfect accuracy. By the employment of these means, we should begin a new system of pathological and physiological inquiry, and arrive at results which no vivisectional experiment could possibly reach. But those who would undertake the task for themselves with any hope of success, must previously obtain a good and practical knowledge of the histology of the nervous centres.

The strength of the chromic acid solution should differ for different parts of the cerebro-spinal centres. For the convolu-

* "Observations on the Structure of Nerve-Fibre," Quarterly Journal of Microscopical Science, Jan. 1860.

tions of the cerebral hemispheres and cerebellum, the proportions should be one of the crystallized acid to about four hundred of water; while for the pons Varolii, medulla oblongata, and spinal cord, the strength of the solution may be in the proportion of one of the acid to about three or even two hundred of water. It is best, however, to begin with the weaker solution and increase its strength at the end of some hours. If the cerebral and cerebellar hemispheres be hardened in a solution of greater strength than the one recommended, they become friable and unfit for making perfect sections.

NOTES FROM DR. GULL.

I saw Dr. P. in consultation with Dr. Day, of St. Andrew's, in August, 1857, and made the following notes of his case:—Age 61. For nine years has been subject to neuralgia in the lower limbs, affecting both equally; varying in seat but not extending to the trunk. Paroxysms of pain lasting some hours, or even several days, and then disappearing for weeks or months. No other symptom than occasional feeling of languor. Five years ago began to have pain in the ball of left thumb, which wasted. Three years ago, one morning, in the class-room, whilst engaged in the usual prayers, became faint; and the speech was confused: he continued the service, and afterwards went through the duties of the class. This attack left him lethargic, and he felt a sinking at the knees. The legs were weak. In walking felt a tightness in the head, and was diffident of crossing a plank. Never had vertigo whilst sitting or lying. Fifteen months ago became more lethargic. Was soon tired on exertion. A walk of a mile would fatigue him. The affection of the arms began about this time. Had vague pains from the shoulders through the arms. The muscles of the right hand became weak and wasted. The uncertainty of gait increased. Took change of air without benefit. Legs more weak, and on two occasions gave way for a moment at the knees. Could not venture to walk down stairs. On returning home was much exhausted from diarrhœa, probably the result of laxatives.

The symptoms had been attributed to gout. For a time the pain left the arms, and fixed itself in both thumbs. It was acute and intermittent. An intense cutting, gnawing, and pricking sensation in the right hand and wrist. Wrist dropped. Muscles of left hand wasted. Almost constant exalted temperature in the feet, and a sense of heat in the hands. Complains that he suffers intensely from accessions of pain in the skin and deeper seated textures of the arms. These accessions

followed by increased weakness. Urine acid; free of mucus, pulse 110. Respiratory movements, both costal and diaphragmatic, normal. Bowels regular, unless when taking opium. Arcus senilis. Muscæ volitantes for years. Right pupil larger than left. Complexion florid. No blue line in gums.

The question when I saw Dr. P. was, whether his symptoms were due to lead. This seemed to me easily negatived by the history and condition of the patient; namely, the gradual progress and character of the symptoms, and the absence of anæmia and the blue line. The opinion, I believe, expressed, was that there was probably some chronic change in the cervical portion of the cord not in any way due to lead. I have no note of having prescribed any medicine. I think I had the impression that nothing would benefit him; and, besides, a sanguine opinion had been given that the waters of Aix-la-Chapelle would restore him to health. In this opinion I did not participate.

NOTES FROM DR. DAY.

I have read the case carefully, and really do not feel that I have anything to add to it; my own shattered health since August, 1857, having prevented me from seeing much of Dr. P., since that time. The following are the only points that struck me:—

Page 4, *line* 4.—When he fancied he was not seen, he was frequently observed by his housekeeper to walk actively about his library and take down and replace books. This he would have solemnly declared to have been an impossibility, if he had been asked to attempt it. I refer to a period of about 4 months before his death.

Page 5, *at bottom.* Besides his urine, 3 gallons of the water from his cistern were analysed, without a grain of lead being found.

Page 9, *middle.*—I have a very strong impression that the dilated right pupil existed before there were any obvious manifestations of his disease. I am almost certain, at all events, that it existed in 1849, when I first saw him.

Perhaps I cannot give a better illustration of Dr. P's. peculiar state of mind than is afforded by the following brief anecdote. An intimate friend calling one day found him reading "Forbes' Essay on the progress of Instruction and Physics," a rather thin quarto. "Ah," said the friend "I am glad to see you strong enough to hold a book of that size." Down falls the book *instanter.* "Oh you don't know, and can't pity the weakness of my hands."

CLINICAL REMARKS ON THE EXFOLIATION OF MUCOUS MEMBRANES FROM THE WOMB AND THE VAGINA DURING MENSTRUAL PERIODS.

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Plate II.

THE structure of the membranous substances which sometimes come away from the womb or the vagina has been accurately determined, but so little is known respecting the conditions in which these products originate, and our means of modifying these conditions are so limited, that I am induced to publish two cases which recently came under my notice. They convince me that such cases are more frequent than is supposed, and that patients are often attended for a long time without drawing attention to what is a sufficient reason to explain an almost indefinite prolongation of the disease. The length of time during which the shedding of the uterine mucous membrane may occur at menstrual periods, explains why so few cases are followed out for a long period, or until the morbid condition has ceased.

Case 1.—A lady, aged 25, of middle stature, healthy complexion, with brown hair and eyes, came to consult me in September, 1860. With the exception of an unusually severe coryza, which had lasted for years and been attended by a very abundant discharge of mucus, the patient had always enjoyed good health until she married at 23. Menstruation first came at 15, and continued regular until marriage; but ever since that period it became more painful, and was almost always accompanied by the passing of some flesh-like substance from the vagina. She was also annoyed by the frequent coming away of a large quantity of a gluey discharge, which did not yield to a very judicious combination of tonic medicines, prescribed by my friend Mr. Hammond, of Ipswich, who likewise ordered vaginal injections, and as there was no pelvic pain and none in the back. No examination had been made. Until two months previous to consulting me, the patient's general health had not suffered, but lately she had complained of feeling weak and

nervous. I found the neck of the womb congested and painful, both lips of the os uteri were deeply excoriated, and so red as to resemble a large raspberry. I considered this to be an instance of uterine inflammation produced by marriage, and the case improved under the influence of an occasional application of the solid nitrate of silver or of its solution. The menstrual period had become due, a small quantity of red mucus was daily passed. When she called on November 20th, I told her to put the feet in hot water, to inject warm water into the vagina, and to apply hot poultices to the abdomen. This brought on the menstrual flow, but it was so profuse and so very painful that Mr. Powell, of Wandsworth Road, was called in. In what was passed, he detected an unbroken sac, which, on being opened was only found to contain liquid blood, and no trace of a fœtus could be discovered by this experienced practitioner. When I saw the patient on the 26th, she was still debilitated by the loss of blood; there were no abdominal pains; no pains on pressing above the pubis; but the neck of the womb was very sensitive to pressure, the eroded surface was of a more fiery red, and there had been more ropy discharge. I coated the abrased surface with the solid nitrate of silver, ordered alum and zinc injections, advising mercurial ointment and extract of belladonna to be rubbed into the skin above the pubis twice a day, and iodide of potassium to be taken in a compound infusion of gentian.

The uterine cast, when brought to me three days after maceration in spirit, was in two fragments, as represented in Plate II, figs. 2 and 3. When adjusted they remind one pretty well of the cavity of the womb regularly distended. Each fragment is about two inches and a-half in length, an inch and a-half wide, and about a line in thickness. One side of these membranes has the rough and floccular appearance of the decidual membrane as it is detached from the womb, and the other side is soft, smooth, and punctuated like the inner surface of the same membrane by the openings of the uterine glands.

This case is well worth discussion. Health was perfect until marriage. Marriage so influenced the womb as to cause it to detach, more or less, its mucous membrane at every menstrual period. Raciborsky has proposed a simple solution for this occurrence by admitting pregnancy and a very early miscarriage in all cases of membranous dysmenorrhœa; but decidual membranes are passed at menstrual periods by virgins, by widows, by women at the change of life, and by married women living apart from their husbands. With regard to my patient, menstruation was regular, there was no sickness, nor any other

sign of pregnancy, no portions of a fœtus were found by Mr. Powell, nor by Mr. Hammond on four subsequent occasions. Thus it is clear that sexual influence, operating directly on the womb, or mediately, by the ovaria, had caused the periodical exfoliation of the uterine mucous membrane, the prime morbid element of the case. What is the nature of this morbid element? For the last two years there has been no evidence of chronic inflammation of the womb during intermenstrual periods, no fixed pain, no red or brown discharge, no nausea; so I cannot give the name of inflammation to a process of the womb which only occurs at each menstrual period. This case confirms Dr. Oldham's idea, that the mucous membrane of the womb exfoliates under some influence independent of inflammation, much better than the cases he has himself adduced; for in his cases, uterine disease existed previous to the passing of the decidual membranes, and a relation of cause and effect might fairly be supposed to exist between the chronic inflammation of the uterine mucous membranes and its exfoliation, as I have shown elsewhere,* and as it has been stated by my friend Dr. Bernutz.† Did uterine exfoliation occur at every menstrual period since marriage? The patient's report is probably correct, for ever since attention has been awakened to the fact, the membranes have always accompanied menstruation. Since the membranes were passed which I have depicted, I have learned from Mr. Hammond that in January two portions of decidual membranes were expulsed with considerable hemorrhage; "that in February, two portions were passed, and although not a cast, he believed it was the lining membrane of the entire uterus." The same occurred in March last, and at every menstrual period except one, up to the September of 1861. In this case I stated, that the prime element is that morbid performance of menstruation which leads to exfoliation of the uterine mucous membrane. The inflammation of the neck of the womb is a secondary element of the case, and was caused by the forcible distension of the neck of the womb necessary to let pass so voluminous a body as that of which I have depicted the fragments. Inflammation of thousands of mucous follicles that line the cervix, explain the abundant ropy discharge; and its alkaline nature accounts for the extensive excoriation of the os-uteri. The monthly repetition of expelling a voluminous body through the neck of the womb, prevented tonics and injections being of much use, and counteracted the usual curative effects of nitrate of silver. I have never met with a case of deciduous dysmenorrhœa which was not accompanied by uterine inflam-

* Lancet, 1853. † Clinique Médicale des Maladies des Femmes.

mation; but is this the cause of the exfoliation, or merely a sequel? As in my case so in many others, doubtless the inflammation of the neck of the womb is only the sequel, and could not induce that condition of the body of the womb which causes its mucous membrane to exfoliate. It is only when distinct symptoms of internal metritis are met with between the menstrual periods, thereby rendered menorrhagic and unusually painful, that inflammation of the body of the womb and the exfoliation of its mucous membrane can be fairly considered to stand as cause to effect, and very few recorded cases contain sufficient evidence to solve the question. As a proof that exfoliation is sometimes connected with uterine inflammation, I may mention that in four of the worst cases of chronic internal metritis that I have met with during the last twenty-five years, the patients had long been in the habit of passing membranes at menstrual periods, although they no longer do so, the menstrual flow being absent or very scanty.

The prognosis of this case is bad. I have kept off the exfoliation for a month or two by leeching the womb before menstruation, and by adopting the treatment advised in this case. The tendency to exfoliation has sometimes worn itself out; after continuing many years, patients have often become disheartened at obtaining no relief, and have sought other advice; and I do not remember being able to attribute the radical cure of similar cases to any one remedy. I have, however, greatly relieved my patients by a judicious plan of treatment.

1. The constant coincidence of uterine inflammation as cause or effect, shows the utility of leeches being applied to the neck of the womb either before or after the menstrual periods, the utility of cooling or astringent injections, and of mercurial and belladonna ointment being applied to the abdomen.

2. The unhealthy condition of the os-uteri and its excoriation render it necessary to touch the parts occasionally with the solid or liquid nitrate of silver.

3. Stricture of the womb often renders dilatation advisable. Even when it does not seem that dilatation of the cervical canal be absolutely required, I have dilated it, with the view of accustoming the neck of the womb to allow the passage of a foreign body without too much pain, and feel confident that I have thus given great relief.

In a little work by Dr. Vannoni, of Florence, there is a case worth translating, so that it may be better known.

Case 2.—Maddelena Marinelli had been married six years when she consulted Dr. Vannoni. She had never borne

children, and for the last three years connection had been very painful. A polypus was found and extracted from the neck of the womb. After its removal the neck of the womb was very sensitive to pressure, and there remained a permanent state of distress and soreness, rather than pain in the right iliac region, micturition was interfered with, and menstruation had not reappeared, when, on the 2nd April, 1832, five months after the operation, and at a menstrual period, frightful abdominal pains caused fever, with delirium and convulsion. The abdomen could not be touched without giving intense pain. This state of things lasted for three days, when blood passed from the vagina, at first in small quantities, then abundantly. On the third day of the menstrual flow, a considerable substance came away, and menstruation continued for the three following days. Externally viewed the substance was red, soft, and smooth, with red dots, more numerous in that portion which had lined the fundus of the womb. The upper portion of it was wider than the lower, and terminated by prolongations, which seemed the casts of dilated Fallopian tubes. The lower portion was cylindrical. The whole body was two inches long and ten lines in width from one oviduct to the other, and seven lines at its lower extremity. On being opened, it was found to be a sac, with an upper cavity of a triangular shape. The inner surface had a velvety floccular appearance, and with a strong lens it was easy to distinguish numerous vessels. It became white on being macerated in water. Dr. Vannoni gives no further particulars of the case, but devotes sixty pages to prove that this membrane was the exfoliated mucous membrane, considering it the result of acute metritis, and comparing it to the cast of an œsophagus which was once brought up, by a patient of his, who had swallowed nitric acid. This perfect cast of the womb is represented in fig. 4, Plate II. As the mucous lining of the womb was detached and forced down, it became inverted, which will explain the fact of the floccular appearance being found inside instead of out, as is usual.

A case related by Chaussier, in his letter to Madame Boivin explains Dr. Vannoni's, for Chaussier says, that he found a tumour hanging from the neck of the womb, with its most voluminous extremity dependent, as if it were a polypus, but the tumour was soft, it easily came away, and was full of blood. It was a cast of the womb, which cast had become inverted.

Occasionally at menstrual periods, membranous substances are passed by the vagina, resembling those of which I have already treated, and I believe Dr. A. Farre was the first to point out that these pseudo-decidual membranes are detached from the

vagina and not from the womb. His communication in the first volume of the *Archives* contains little clinical information respecting these singular products, so I think it is well to relate the following case respecting which opinions may be divided:—

Case 3.—A highly respectable, strong, healthy-looking woman, aged 24, consulted me on the 26th of February, 1861. Menstruation came at 14, was quite regular, not very abundant, but very painful until her 20th year, when she began to suffer so much with bearing-down pains, pains in the back, and had so much difficulty in getting up and down stairs, that she was obliged to give up her place as lady's-maid. Menstruation was unusually painful; leeches externally applied, and blisters, gave no relief. She was for a time under Dr. Simpson. No painful treatment was adopted, carbonic acid injections were made three times, and a sponge pessary ordered and worn for a year. This treatment had been continued without favourable results for three years, when I saw the patient. On careful examination I found a virgin womb, apparently healthy, with the exception of its being lower down than usual. The patient complained of bearing-down and back pains coming on soon after she walked or stood about; otherwise she felt well, so I merely ordered alum vaginal injections to be used twice a day. There was no fixed surpubic pain, no brown or red discharge, which so often indicate inflammation of the lining membrane of the womb. A few days after she brought me a membranous substance which had come away with a blood clot during an unusually painful menstrual period. On examination I found nothing unusual in the appearance of the womb nor of the upper part of the vagina; nevertheless I ordered the patient to rub into the skin above the pubis, an ointment made of extract of belladonna and mercurial ointment. The drawing fig. 1, Plate II is a very accurate representation of the membrane which was passed. Its upper portion is evenly defined, like the plait of a folded bladder, with rounded angles, without openings for the Fallopian tubes. Its lower outline is irregular, jagged, and filmy, as if irregularly torn off from an extensive surface. It is about 2 inches broad and 1½ in length. It must have lined a vaulted region, and its two sides must have been pressed against each other by a blood clot, or some other substance. Both sides of this membrane are very much alike. It is not thick and pulpy, like decidual formations, but thin, and, after immersion in spirit, looks like soddened parchment, here and there stained with blood. It has not on one side the cribriform appearance resulting from the opening of the uterine glands.

On being examined microscopically by Dr. Beale, pavement cells were distinctly found.

Has the condition which led to the formation of this membrane any relation to the patient's sufferings for the last four years? I do not know this to be the fact, but I believe it to be so. Did she ever during that period pass similar membranes? Probably; for during the following catamenial period she passed a solid substance, but as it was partly decomposed, I could only ascertain that it was similar to the one I have described, only thicker by superposition of membranous flakes. On the 21st of April, she had just menstruated with little pain or clots, and no membrane had been passed. The patient was certainly better, had less pain, could walk more, and was told to continue the mercurial ointment, the injections, the cold sponge-bath, and to rest a couple of hours on the sofa in the middle of the day. On the 22nd of May, menstruation had ceased; a few clots, but no membranes, had been passed, with slight pain. The patient is going to the sea-side, will bathe, and continue to use astringent injections, but leave off the mercurial ointment, which has been continued three months. I sanctioned the patient's being married in three months, believing that it would be rather beneficial than detrimental, particularly if pregnancy were carried to full term,—a rare occurrence, for sterility is common when the womb exfoliates its mucous membrane at catamenial periods.

The foreign body passed by this patient is so similar to one observed by Dr. Farre, that I might have used his words in describing my preparation. The absence of the cribriform appearance, the thinness of the membrane, the presence of pavement cells, led him to admit that it came from the vaginal cul-de-sac, but it may be first argued on general principles that the structure of mucous membranes becomes so modified by inflammation, that pavement cells might possibly be developed in the mucous membrane of the body of the womb, which was composed of ciliated epithelium in its normal condition, and however singular this position may appear, it is assented to by Dr. Beale. Arguing from the peculiarities of the case, it may be said that the membrane does not clearly shew its vaginal origin by a well defined tubular shape, by bearing the impression of vaginal rugæ and by presenting a cup-like depression made by the extremity of the neck of the womb, as in other specimens delineated by Dr. Farre, about the vaginal origin of which, there can be no doubt. The membrane is exactly like a fragment of a collapsed bladder, so long folded that the plait remained permanent, and one can understand that this was done by

pressure of the blood against the side of a distended womb; but I cannot understand how this could have taken place in the vaginal cul-de-sac. Moreover, it is not rare in certain forms of vaginitis for the epithelium to be thrown off in large shreds, which look exactly like the film on the surface of liquid paint when exposed to the air. In such cases there is a certain amount of redness and sensitiveness of the vagina, whereas I found the vagina perfectly healthy on examining my patient, once immediately after menstruation, and again immediately before and after a subsequent menstrual period, on two occasions when the membranes were passed. Neither this patient, nor that patient of Dr. Farre who passed an exactly similar membrane complained of rawness and vaginal distress which were marked symptoms of the cases related by this accomplished observer in which the product was evidently detached from the vagina. It would be singular, if, while the exfoliation of a thin pellicle is accompanied by distinct symptoms of vaginitis, the exfoliation of a much denser substance from the vagina should give rise to none at all. For these reasons I believe that this membrane, although differing from the well-known decidual membranes was still formed in the body of the womb, but the question requires to be reconsidered by the light of other cases.

A CASE OF ACUTE WAXY DEGENERATION OF THE LIVER AND KIDNEYS.

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Case.—Geo. M., an errand boy, æt. 16, well-built, and having always enjoyed good health up to the commencement of the present illness, came under treatment at St. Mary's Hospital on December 4th, 1860. The only fact about his previous mode of living bearing at all upon his illness, which I subsequently ascertained, was that he was passionately fond of fishing. In the pursuit of his hobby he was often exposed to wet and cold; and notably one night last summer he slept in the open air, in a hayrick, in order to be in good time to commence sport in the morning. His circumstances were easy, and there was no appearance or trace of any hereditary taint.

He had felt general pains in his limbs for about two months past, and was troubled with slight cough; there was some effusion under the left patella. His usually florid complexion had left him, and he had become pale and emaciated. He complained of general debility more than any other symptom. The skin was rather sallow than jaundiced, the urine high coloured but not containing any biliary matter, the tongue clean, the pulse 116. There was persistent constipation, and trifling pain in the region of the liver. On undressing, the whole

upper and right side of the abdomen was evidently full and distended, and on closer examination the liver was found to be very much enlarged, extending from the sixth rib to within two inches of the umbilicus, and stretching across the epigastrium into the left hypochondrium. The surface of the liver was perfectly smooth, and appeared to be elastic, though neither fluctuation nor hydatid remitus were discoverable. The lad had noticed the enlargement of the abdomen only for one week. At the ensiform cartilage, the right half of the body was half an inch larger in circumference than the left side. When he was first taken ill, he had pains all over, and particularly in the middle of the back. At first he occasionally felt sick, but never vomited. It was only during the last month that there had been any loss of appetite. The view taken at the first consultation was, that the lad was labouring under intense congestion of the liver, to which alone the great enlargement of the organ seemed referrible. He was ordered a purgative powder of calomel and jalap, to be taken every morning, and to have eight leeches over the liver.

December 5.—The leeches have entirely removed the pain in the right side, the bowels have acted; the urine is turbid, of a dirty yellow colour, acid, sp. gr. 1024, contains copious lithates and some albumen, but no bile pigment. Tongue dry, there is thirst, the pulse 116 and small.

December 7.—The left knee continues swollen. The abdomen seems a little reduced in size, but on measurement exhibits the same dimensions. To have an ounce of sulphate of magnesia mixture twice a day.

December 11.—The hepatic dullness is somewhat increased downwards; there is some tenderness over the right lobe; the bowels are well open; the pulse is 120, small; the tongue is clean, there is thirst; the urine is clearer. Repeat the sulphate of magnesia mixture twice a week, and take steel wine two drachms three times a day.

December 14.—General symptoms the same, but the emaciation is increasing; the urine reported as being quite clear.

December 29.—The urine has again become dark. There is more tenderness over the hepatic region; the bowels are open, but the motions are pale, very light coloured. There is great thirst, and a quick pulse. He has no sickness. For four nights has had no sleep. To have extract of taraxacum one ounce, decoction of cinchona eight ounces; of this, take one table-spoonful twice a day, and the Epsom salts as before.

January 1, 1861.—Looks more anæmic, and emaciation continues. There is more abdominal pain; he feels sick, and has no appetite.

January 4th.—Entire loss of appetite; increasing emaciation. There is much pain over the lower abdomen, and great thirst. The urine is of a brownish red colour, and contains much albumen. Two nights ago there was much dysuria. The motions are dark. Repeat the mixture. About this time he ceased attending at the hospital. I therefore visited him at home; hitherto there had been no material alteration in the form or size of the liver, to which attention had been chiefly directed, but on

January 8, I discovered a very marked reduction of this organ; it had shrunk since the last examination up to the margin of the ribs, and the dullness did not reach higher than previously, viz., to the sixth rib. The lower edge felt hard and sharp, and could be readily grasped in its whole extent. At the same time there is general pain over the whole abdomen, which is resonant on percussion, but not distended. The urine is clearer; the pulse 100, full and soft; the tongue furred and brownish. To apply leeches to the abdomen. The opinion which lately had been fluctuating somewhat regarding the nature of the disease, seemed now rather towards the view that the case was one of hydatids, that these had burst, and had given rise to peritonitis; but the peritonitis was scarcely severe enough to justify this view, though the sudden reduction clearly indicated the impossibility of our having to deal with medullary cancer, which the rapid growth of the organ, the youth of the patient, and the great and rapid emaciation had seemed to indicate, when the treatment directed against the congestion, and continued for some time, had apparently failed to reduce it.

January 9.—Had a good night after the leeches, which have much relieved the pain. Tongue clean, pulse 92, thirst less, urine clearer. Abdomen still a little tender, percussion of liver the same as yesterday. Bowels costive. To have castòr oil.

January 16.—The symptoms continued much as at last report for some days; on this day the account is:—There was much pain in the abdomen last night, so as to prevent sleep. The liver is felt just below the margins of the ribs. Except round the umbilicus, where the percussion is tympanitic, the abdomen is dull, and there is distinct fluctuation at the lower third. When the hand is laid flat on the left upper side of the abdomen, and the patient breathes deep, a distinct crepitus is felt; pulse 88. Great thirst. Tongue clean; appetite pretty good, but he fears to eat, on account of the pain in the stomach, which shoots up the left side of the chest. Urine very thick and dark. Bowels open. On account of the evident return of peritonitis, six leeches were applied to the left side of the abdomen, and the following powder given three times a day:—℞ Hydrargyri cum Creta, gr. ij, Pulv. Ipecac. Co. gr. vj.

January 19.—The bowels are very costive, were moved once last night. Since last visit has been very sick, and has vomited some blood. Increasing emaciation. There is less pain in the abdomen, which, however, is more distended. He has slept pretty well. The tongue is clean, but rather dry. Pulse 104, full; the urine brownish, very dusky, and acid.

January 21.—Much as at last report. The urine is turbid, dirty yellow, and strongly albuminous. Examined by the microscope, it exhibited epithelial casts, with blood corpuscles and epithelium scattered over the field. The casts or epithelium more or less discoloured by hæmatine. There was also large pavement epithelium, and numerous minute uric acid crystals.

January 23.—The vomiting continues, the ascites appears to increase, but there is no œdema. The urine continues the same. The pulse is feeble, 84; the tongue moist, slightly furred; there is no appetite, and he sleeps badly.

January 26.—On the 24th instant, he had copious epistaxis for twelve hours; there is a purpuric rash on both legs. The motions are reported to be very dark. The anæmia is extreme.

February 1.—Bowels not moved since last visit. The urine very scanty; the emaciation and anæmia increasing; the pulse very feeble; the tongue swollen. Had four convulsive fits (uræmic) last night, for the first time in his life; for several days has vomited bilious looking liquid. Was asleep during the visit, and too drowsy to be examined minutely.

He died on the following morning, after a repetition of the convulsive seizures. From 1 a.m. up to the fatal event, he had about nine attacks, and was quite insensible in the intervals. Death took place during a convulsion; there had been no return of the hemorrhage, but the purpura on the legs endured to the end.

Post Mortem, Feb. 3rd, 22 hours after death; assisted by Mr. Staples.

The body was much emaciated; the rigor mortis had almost entirely disappeared; the purpuric spots still visible on legs. Only the chest and abdomen were examined. On opening the latter the first thing that struck the observer was the large amount of blackish pigment in the omentum, on the upper part of which, towards the spleen, there was some recent fibrinous exudation.

Spleen much enlarged, measured 9 inches by 4, and appeared to be about 2lbs in weight, of a purple colour, and having fibrinous exudation over the whole outer surface, and

evidently quite recent. Two "fibrinous" blocks showed on the outer surface of the spleen, of a pale yellow colour; the one at the upper, the other at the lower part, dipping deep into the structure of the organ, and having (as usual) a sharply defined margin. One was of the size of a walnut, the other of a filbert. The structure of the spleen otherwise appeared normal. The upper part of the spleen was adherent to the left lobe of the liver by tough adhesions. The lower edge of the spleen was in contact with the left kidney, the upper third of which was of a purple colour, as if stained by the spleen, but microscopical examination subsequently showed the discoloration to be due to the deposit of black pigmentary matter in the canaliculi.

The *liver* was smooth on the surface, and showed considerable fibroid thickening of the glissonian capsule, its weight was guessed at 3lb. The whole organ was very dense and hard, and at a distance presented a dark reddish-brown hue, as if congested. On section, however, it was found to contain little blood, and to cut very hard and dry, but without any appearance of fatty deposit. On close examination it presented a finely marbled appearance, as if containing a large amount of new matter or deposit, disposed with tolerable regularity among the proper hepatic tissues. This "new" matter had a translucent, horny, whitish appearance, and pervaded the entire organ very equably. The intervening red tissue looked granular in comparison; the former predominating somewhat. The gall-bladder was full of dark green bile.

The *kidneys* were both alike; the upper ends of a dark blue colour, which penetrated into the organs to a considerable depth. The capsule was not adherent in either, and their surfaces were perfectly smooth. But the latter presented the same marbled appearance which was noticed in the liver, and on section there seemed to be the same "new" matter or deposit through the cortical tissue of both kidneys, exhibiting a pale yellowish or whitish, finely granular appearance. Both kidneys were rather large. The *bladder* was full and distended. There was a small quantity of fluid in the peritoneal cavity. The stomach and intestines were not minutely examined, but appeared healthy.

Both *lungs*, but particularly the right, were very strongly adherent; except some hypostatic congestion, the tissue of both was perfectly healthy; there was no tubercle.

There was a small quantity of serum in the pericardium, which had a little fibrine on the surface. The heart was pale, flabby, and all its cavities quite empty. There was a large

fibrinous excrescence attached to the aortic valves, and extending to one of the curtains of the mitral valve.

Microscopic appearances.—Fine sections of the liver showed the deposit to surround chiefly the intralobular veins, which were empty; while the little blood that remained filled the interlobular veins. The deposit had a semitranslucent horny or waxy appearance, its margins were well defined, it contained no trace of oil, nor was there any oily matter to be seen throughout the organ. Nor was there any appearance of pigment in what I have called the deposit. Under a high power, the so-called deposit proved to consist entirely of hepatic cells in a state of extreme atrophy, perfectly transparent without a trace of oil or pigment. The cells were not fused or broken up, as seen in cases of extreme waxy degeneration, but were defined in outline though varying much in shape and size, evidently undergoing metamorphosis. The kidneys presented exactly the same degeneration as the liver. The epithelium being wasted in the same way, having a glassy or waxy appearance, which was peculiarly marked in the malpighian corpuscles.* The yellow blocks in the spleen consisted of granular and corpuscular fibrine, without trace of organization; the same was the case with the deposit on the cardiac valves, but here there was also some crystalline deposit of mineral matter.

Remarks.—It appears evident that the original view, that the enlargement of the liver was due to congestion, was the correct one. It appeared negatived at first by its persistence in spite of treatment, and by the extreme weakness and increasing emaciation of the lad, and the only reasonable conclusion then seemed to be that the disease was one of encephaloid growth. When, however, within a few days, a sudden reduction, followed by symptoms of peritonitis, took place, it naturally suggested itself that there might have been a rupture of an hydatid cyst, though this view did not gain much hold from the comparative slightness of the peritonitis. In short, although at last the uræmic poisoning, the scorbutic epistaxis, the purpura, and other symptoms of entire decomposition of the blood, left no doubt as to the degenerative character of the disease, it was left for the autopsy satisfactorily to account for the whole train of occurrences. I should be disposed to view

* The cortical part of the kidneys also exhibited a considerable amount of black, amorphous pigment. Drawings of the naked-eye and microscopic appearances were taken, but it is thought that the descriptions given may suffice to render them intelligible.

them briefly thus: In consequence of the catarrhal influence to which the boy, previously in perfect health, was exposed in the latter part of the summer of 1860; he had a subacute rheumatic attack, with incipient degeneration of the kidneys. This was not attended to, and consequently congestion of the liver took place, which reached the extraordinary extent which it had when I first saw him. At this time the kidneys were but slightly affected; in consequence, however, of continued purging, and more still from the kidneys putting on fresh diseased action, and becoming themselves very much congested (the urine at one time being persistently bloody), and also from the spleen enlarging considerably, the liver became reduced in size. The degenerative process had in the meantime been established in the liver, and continued to progress. The chief depurative organs of the body being diseased to the extent shown after death, and the central organs of circulation being also materially impaired, it was only a wonder that death was so long postponed. The exact period at which the heart became affected cannot even be surmised upon the vital symptoms, because no cardiac symptoms were ever noticed; from the post-mortem evidence it is probable that the deposit on the valves took place early in the disease, probably after the morbid affection had commenced in the kidneys. I should accordingly determine the succession of disease in the different organs in the following order,—1, kidneys; 2, heart; 3, liver; 4, spleen, and kidneys a second time.

It has been suggested to me, that the whole view about an enlargement of the liver was a mistake. Upon this point, however, I have no doubt. The upper margin of the liver never varied, and the organ was repeatedly percussed, in the presence of students, with too great care to permit of the possibility of any doubt on the minds of those who watched the case. Besides, there never was anything in the thorax to push the liver down, nor was the distension of the abdominal cavity ever such as materially to influence the position of the liver. I much regret that no analysis could ever be made of the fœces, of the vomit, nor of the perspiration; the case might have been exploité in many ways more than I have done, more particularly with regard to the amyloid question, but the opportunity and time was wanting to complete it as it would have been desirable.

Such as it is, however, it has appeared to me to be sufficiently remarkable to bring before the profession, the more so as it is the first case published in which there is reasonable evidence of the period within which waxy degeneration takes place, and an

account of the course of the entire disease from beginning to end. The whole period only amounting to four months, we should not be far wrong in calling it a case of acute waxy degeneration of the liver and kidneys.

CASE OF RUPTURE OF THE HEART, CONSEQUENT UPON WASTING AND SOFTENING OF THE MUSCULAR TISSUE.

By J. T. Arlidge, M.B., A.B., M.R.C.P. Lond.
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Case.—W.E., æt. 66, an independent gentleman, consulted me in February 1860, on account of a general feeling of illness, accompanied by uneasiness and pain, chiefly in the left hypochondriac region. This pain frequently extended across the epigastrium to the right side; became worse about an hour after taking food, when it was also felt between the shoulders and beneath the left scapula. There was considerable flatus from the stomach, with nausea; and a few days previously he had vomited food, a circumstance he attributed to having taken some medicine containing morphia. Pulse 80, weak, very compressible, but regular; skin soft, moist. Tongue covered by a soft, white coat; dry, according to his statement, in the morning. Bowels open daily, but less freely, for the last few days, than usual. Evacuations well coloured with bile. Urine in sufficient quantity, but loaded with lithates. No marked sallowness of face or of conjunctivæ; but the features appeared relaxed, and the countenance was indicative of feebleness.

Two or three days before consulting me he had taken a blue pill and a black draught, without relief, however, of his symptoms. Had taken little food, and drunk only very moderately of sherry. Moreover about ten days before, he experienced, on one occasion, a feeling of faintness, and afterwards complained of an aching in the neck, shoulder, and arm of the left side; this he attributed to the effects of cold, and obtained relief by wearing flannel over the affected parts. There was no loss of power in the arm and hand, nor was the sensibility affected in them.

He was a man of short stature, but well formed, and had a well-developed chest, was partially bald and rather grey. He had been living privately for 26 years; leading a very quiet life with his family; living regularly and frugally at home, and, although he always drank wine, he was abstemious, and mostly took sherry or claret. At the same time he was not indifferent

to good living, and was able to indulge in it sometimes, as he was a member of a wealthy city company. However, when he did indulge in eating and drinking, beyond his custom, he suffered pain in his chest, and dyspepsia. He was of a nervous, sanguine temperament, active, and fond of being busied in parochial matters.

Altogether he had enjoyed good health; about 10 years ago he had an attack of "bilious fever," with severe and long-continued vomiting, and followed by great debility. Since then he has had no serious illness, although he has often suffered from pain in the chest and dyspeptic symptoms, for which he has had advice; and on three occasions his chest was examined, one medical man stated that there was heart disease; but the other two, in whom he had particular confidence, assured him of the perfect soundness of the heart. And it should be remarked, that there never were any secondary or general symptoms of heart disease.

The eminent surgeon, whom he usually consulted, told him he suffered from disorder of the liver, and treated him with the iodide of potassium, carbonate of potash, and aperients; and he attributed the pain in the chest to muscular rheumatism; but neither rheumatism nor gout had ever shown themselves elsewhere. Under the advice of his medical man, he went to Brighton, and took about a dozen hot sea-water baths, at as high a temperature as he could bear, but without material benefit.

I prescribed for him a simple aperient mixture and pills. After seeing me, he walked for about a mile. During the night he was restless and complained much of the pain across his chest. A hot bran poultice applied gave little relief. His wife observed his breathing to be quicker than usual, and that he appeared very uneasy. However, he got through the night, rose about 8 o'clock, dressed and went down stairs; told his wife and daughter he felt much as usual. On coming down stairs he went to the water-closet, and after being there a short time, was heard to fall and to groan two or three times. I saw him almost immediately; found him lying, doubled up in the narrow space within the closet, and quite dead. The body cooled very rapidly, was at first pallid, and then for a short time, dusky.

On the third day after death, I made a post-mortem examination. Skin peculiarly soft, smooth, and wax-like in appearance; slight discoloration on the under surface of the body. About an inch of firm, but oily subcutaneous fat. Muscles deeply coloured. Chest—lungs healthy, without adhesions;

containing much blood of a venous hue, particularly in their dependent parts. Diaphragm thrust upwards by distension from flatus in the abdomen. Considerable fat in the anterior mediastinum and about the pericardium. This last was greatly distended, and on cutting into it, a large quantity of dark sanguineous fluid escaped, and afterwards masses of soft, dark, clotted blood; which, besides filling the pericardium, had stained its inner surface. On raising the heart, an irregular fissure was seen in the front wall of the left ventricle, about one inch from the apex, and rather above an inch in length. Its border was irregular, and the surrounding tissue readily broke down into a pulpy mass. The tissue was deeply coloured, soft, intermixed with dark grumous matter, and entirely destitute of its muscular characters. On opening the ventricle, the whole of its interior, from the site of the rupture to its conical apex, exclusive of the interventricular septum and the portion just within the mitral valves, was found in a disintegrated state, its surface irregular, and of a dusky grey colour. The softening and atrophy of the muscular tissue of the ventricle had proceeded so far, that its wall was reduced to one-fifth of an inch in thickness. This change in structure extended on each side as far as the septum, which was itself unaffected. The mitral valves contained no calcareous deposit, and although their muscular columns were rather softened, they had been able to maintain their action. The aortic semilunar valves were healthy, except that the little corpus arantii of each had a small deposit upon it of calcareous matter, in the form of little spicula, projecting in a stellate or tuft-like form. The semilunar valves of the pulmonary artery had no such deposit. The right ventricle was smooth internally, as usual; its walls were thin, and their muscular tissue atrophied. The tricuspid valves were diseased, having a blood-coloured, pellucid-looking deposit in their thin membranous portion, causing a certain amount of thickening.

A large quantity of yellowish, firm, and rather transparent fat, surrounded the auricles and the base of the heart. The coronary arteries, both at their origin and in their course, were converted into calcareous tubes; whilst the aorta was itself largely occupied by similar calcareous deposit. The whole heart was rather small, and its muscular tissue throughout thinner and softer than normal, and of a dusky red colour. Both ventricles contained clotted blood.

Abdomen.—Stomach large; veins filled with blood; it contained much gas, but only a little pulpy food. No signs of disease were manifest in its coats. The duodenum exhibited

signs of chronic duodenitis; was rather contracted; of a dusky reddish colour internally, with injected vessels. The pancreas was much altered in character, being of a reddish-grey hue and very soft. The pancreatic artery was converted into a calcareous tube. Liver of a light brown colour; in an early stage of fatty degeneration; presenting wavy lines in all directions, closely aggregated. The gall-bladder contained some thin bile. Both large and small omentum loaded with fat.

A microscopical examination of the diseased tissue of the heart displayed the destruction of the normal muscular tissue, for though, at some parts of the wall of the left ventricle, the outline of muscular fibres was discernible, their true histological characters were lost; whilst in the disintegrated mass, nothing but granular matter, altered blood, and a few fat globules were discoverable. The microscope further showed that, though fat corpuscles occurred, the lesion of tissue could not be called a fatty degeneration.

There can be no question that the destructive lesion of the heart had been progressing insidiously for a long period. Considering the extensive destruction of muscular tissue in the left ventricle, it is astonishing that the heart should have so long carried on the circulation with sufficient force to maintain life. The softening of the wall was such that the very act of contracting upon its fluid contents seemed scarcely possible without rupture; in fact, it did at last tear, but it is remarkable that it did not tear before, and particularly during the exercise the patient was habitually taking. The irregular and softened internal surface indicated the breaking down or deliquescence of tissue which must have at once entered into the circulation; a circumstance which we cannot conceive to have occurred without producing some effects, not equal to those of the circulation of pus, but of a parallel character. And yet, there was no very appreciable sign of such effects; the feeling of powerlessness is attributable to the weak heart, and the thirst and dyspeptic symptoms to the chronic duodenitis. To this last too was most likely due much of the pain about the chest and between the shoulders; but was any of the thoracic pain due to the lesion in the heart? The dark, grumous blood which had escaped from the left ventricle, did it owe its characters to the effects of morbific matters entering into it from the broken, up muscular tissue? There was no lung disease to interfere with the due aëration of the blood, and no other discoverable cause for the alteration of the arterial blood. Lastly, was not the diseased state of the coronary arteries the principal cause of the atrophy and softening of the tissue of the heart?

SEQUEL OF A CASE OF ACUTE PERICARDITIS WITH EFFUSION NOT OCCURRING IN CONNECTION WITH RHEUMATISM.

UNDER THE CARE OF DR. BEALE.

The history is given at page 92, vol. II. of the Archives.

Notes made during the last month by MR. HARRISSON,
Resident Medical Officer to the Carey Street Dispensary.

The Post Mortem by MR. C. J. WORKMAN,
Assistant House Physician, King's College Hospital.

THIS man, aged 20, was admitted into the hospital in January 1860, and had a severe attack of what might fairly be termed idiopathic pericarditis with effusion. He recovered and left the hospital, but the effusion reappeared about three weeks afterwards, and he again became an in-patient in March. The fluid appeared to be entirely absorbed in the course of a month, although there was still considerable dyspnœa.

In the September following he was admitted a third time. (Vol. II, p. 111.) There was considerable dyspnœa, his lips were blue, and there was much fluid in the abdominal cavity. The abdomen was 37 inches in circumference. The heart's sounds were feeble, but no bruit was audible. The cardiac dulness extended to a point an inch and a half to the right of the median line of the sternum,—upwards, as high as the third costal cartilage. The apex beat in about the natural position.

The right external jugular vein was much distended, and when the finger was placed over it and the contained blood forced downwards, it instantly refilled below the point at which pressure was made.

Crepitation was heard at the lower part of both lungs behind, but was loudest on the left side where there was also some dulness towards the lower part. Occasionally a little blood was expectorated with the frothy mucus.

The conjunctivæ were yellow, and the urine was of high specific gravity and contained bile, but no albumen was detected.

The ascites was somewhat relieved by cupping over the kidneys, purgatives and diuretics, but no great improvement in his general condition occurred. The man remained in the hospital till November 27th, when he was discharged at his own request. Soon afterwards he came under the care of

Mr. Harrisson the resident medical officer of the Carey Street Dispensary, who kindly furnished the following notes.

"The following was his condition on December 24th :—He was lying on his back in bed, and seemed to be suffering from much dyspnœa; his cheeks were flushed, lips pale, skin and tongue dry, the latter rather coated. The veins of the neck were large and prominent. The abdomen greatly distended, fluctuation everywhere distinctly perceptible. Dulness on percussion, except at the upper part just above the umbilicus, where there was a tympanitic sound over a small extent of surface. Both sides of the chest were resonant on percussion, except over the lower part of the left lung, which yielded a dull sound, and this dulness extended to the region of the heart. Mucous râles were audible in both lungs. He complained much of his cough, and expectorated freely. On examining the heart, no bruit or abnormal sound could be detected, though its action was irregular and sometimes tumultuous. Pulse feeble and irregular, the artery never feeling evenly distended. Urine scanty. Bowels confined. Ordered some linctus for his cough, and to continue the other remedies he was taking, viz.: Pulv. Jalapæ Co. ʒss. occasionally, and the following draught three times a-day: ℞ Potassæ acetat, gr. xx, Sp. Junip. Co. ♏ xi, Sp. Æth. Nit. ʒss., Infus. Quassiæ ad. ℥j. M.

Dec. 26.—Dispnœa increasing; complains of great distension of the abdomen; cough easier, and he has rested rather better than usual at night. Urine very scanty, thick, and cloudy, sp. gr. 1·26; contains a large amount of urates, and a small quantity of phosphates; no albumen. To continue the same, with the addition of a grain of calomel to the powder.

Jan. 3.—His distress so great, that Mr. Wood was asked to see him, and the following day performed paracentesis abdominis, and drew off 20 pints of clear greenish yellow fluid. Ordered chloric and nitric ether, with ammonia, and a grain of opium at bed-time.

Examination of Fluid.—Quantity, 20 pints. Clear, bright, greenish-yellow colour. Sp. gr. 1·19. Contains a large amount of albumen, the mass of precipitated albumen half filling the test tube. After standing twenty-four hours, the fluid had separated into a flocculent mass which had gravitated, and a clear supernatant liquid, which retained the greenish-yellow tinge.

January 5 to 8.—Very comfortable; had slept better, and his cough and dyspnœa much relieved. The suffusion of the

countenance had disappeared, the veins of the neck were far less prominent, and his pulse was more regular and somewhat stronger, though still retaining its peculiarity. He expressed himself much relieved, but complained of a few slight abdominal pains, which were dissipated by a mustard poultice. Breathing and cough much easier. The stethoscope reveals only a few mucous râles. The dulness on the left side remains. To take ammonia, nitric ether, and compound spirits of juniper, with paregoric.

January 9.—Continues better, makes rather more water, which contains no trace of albumen. Bowels regular. The fluid is accumulating again rather rapidly. Has been sitting up for a short time to-day, but finds when he does so that his feet and legs become œdematous.

January 21.—Cough becoming distressing again, and there is a return of mucous râles. Distension of abdomen rapidly increasing. Makes less water than he did.

January 25.—Dyspnœa and cough very distressing. Forehead covered with a cold clammy sweat. Countenance suffused, and conjunctivæ slightly injected. Pulse very feeble and irregular.

January 28.—Distress so great, that Mr. Harrisson asked Mr. Wood to see him, who thought it advisable to repeat the operation of paracentesis, which he did, and took away twelve pints of fluid, which proved to be chemically and physically the same as the last. It was necessary to stimulate him frequently with brandy, and he was ordered to continue it occasionally.

January 29 and 30.—Declares himself easier, and slept more comfortably. Pulse very feeble. Appetite bad.

January 31.—The first part of the morning he seemed better and was quite cheerful, but about 10.30 he began to complain of pains in his head and right side over his liver, and shortly afterwards fell into a deep sleep. When he was visited, he was lying on his back, breathing heavily, his lips livid and face flushed. He was with difficulty roused, and then partially, and immediately he would fall again into a deep sleep. Pulse scarcely perceptible. Ordered brandy and chloric ether, ammonia, and tinct. serpentar.

He died a few hours afterwards. He was conscious, and recognized those about him before he died.

Post Mortem, February 2, conducted by Mr. C. J. Workman, who made the following notes:—" Body rather emaciated. When the abdomen was opened, its cavity was found to contain several pints of fluid, with some loose flakes of lymph;

there were no marks of inflammation about the site of the tapping.

The upper part of the anterior wall of the peritoneum, extending from the lower margin of the ribs to the umbilicus, presented a mottled black appearance, resembling ecchymosis. The anterior wall of the thorax having been removed, and the pericardium opened, the latter was found much thickened, it was not adherent anteriorly, but slightly so along the left edge and apex, and also along the whole base. It contained no fluid, but some flakes of soft lymph at its lower part.

The Heart measured, in circumference, round the base of the ventricles, and following their outlines, 11 inches. The length of the whole heart was $6\frac{1}{2}$ inches. The transverse diameter, at the junction of the auricles with the venticles was $4\frac{3}{4}$ inches. All the cavities were dilated. The left ventricle was about $\frac{3}{4}$ inch thick at the apex, about $\frac{3}{8}$ inch thick higher up. The aortic valves were healthy.

The *aortic orifice* measured $2\frac{7}{8}$ inches in circumference; the commencement of the aorta $2\frac{1}{8}$ inches.

The *mitral valve* admitted two fingers, the posterior valve was rather thickened and contracted; the anterior lip was healthy.

The *right auriculo-ventricular opening* barely admitted two fingers.

One lip of the tricuspid valve was healthy, the other two lips seemed so contracted and entangled that it was impossible to define them.

The *pulmonary valves* were healthy.

There were old firm adhesions of the pleura everywhere, on both sides. The lower part of the lower lobe of the left lung was carnified, and the pleura over it much thickened. The rest of the lungs was congested, and contained no trace of tubercle.

Liver.—The omentum was adherent along its anterior edge, concealing the stomach as if it had been pushed upwards by the peritoneal fluid. The liver was adherent behind to the diaphragm, it was of normal size, its structure was congested and soft.

Spleen appeared to be pushed upwards, it was nearly three times its natural colour, and greatly congested.

Both kidneys were also much congested, but otherwise appeared healthy."

ON TAKING CASES, AND MAKING POST MORTEM EXAMINATIONS,

By Lionel S. Beale, M.B., F.R S.

SUGGESTIONS FOR TAKING CASES.

The following suggestions are published in the hope that they may be practically useful to those engaged in clinical observation, especially in the wards of a hospital. The matter has been condensed into the smallest space consistent with clearness, and reference has only been made to the most important points which should engage attention. It is obvious that such a scheme must be very defective in many ways, but it is hoped that it may help to diminish the difficulties of reporting cases, and remind the reporter of some of the principal points to be inquired into, while he is actually at the patient's bed-side.

The order I have adopted is the one followed in my own case books, but it may easily be modified, if thought desirable. Throughout, I have endeavoured to make the arrangement simple, and to place the subject of inquiry in order. It will be found, however, that I have sacrificed theoretical classification to practical convenience. Some apology is due for the insertion of a paper on elementary work of this kind in the "Archives," but I have been so frequently asked to arrange a scheme of the kind that I could not but make the attempt. I have added short notes on the terms generally employed in reporting cases, and a condensed report on the chemical and microscopical examination of the secretions.

It is not necessary for the Clinical Observer to note all the points alluded to in the following sections, but he will select those which he considers necessary in the particular case under examination.

The questions to the patient should be simple and precise. The facts ascertained should be expressed in as few words as possible, consistent with perfect clearness. No indefinite terms should be employed. The patient should always be made to place his hand over the part which he considers as the seat of his malady.

Long descriptions of the precise seat of the affection may often be avoided, by the use of the blank forms described in vol. ii, p. 97—the organs supposed to be altered being indicated by shading.

It is desirable to adhere to the order recommended, as far as practicable.

The case book may be large (8 inches × 13) or small (6 inches × 8), but in all cases a margin of at least an inch and a half should be left on the left side of the page, and it is better to write on one side only.

I. TO BE NOTED IN EVERY CASE.

Date and Time of the observation.

Name, Age, Address, Sex, Married or Single, Children, Date of birth of last child, Occupation.

Locality, Drainage, Water, Smells, &c.

Height, Weight,* General Nutrition, Muscularity.

Quantity and Nature of Food, Amount and Kind of Stimulants taken, **Well or Badly Clothed.**

II. PRELIMINARY ENQUIRIES.

What is the Matter? Where does the Patient Suffer?†

General Health, Previous Illnesses, How Treated.

Was the patient well immediately before the present attack (*acute affection*) or had he been ailing for some time previously (*chronic affection*)?

Description of present Attack.

III. FACTS ELICITED BY GENERAL OBSERVATION.

Face, Complexion, Expression, Colour, Puffiness, State of Eyes, Pupils, Lips. **Voice and Speech:** thick, hoarse, difficulty of articulation, cough. **Mouth:** teeth, throat, &c. **Manner:** intelligent, excited, dull, drowsy. Posture, in and out of bed. **Surface generally:** cold, hot, dry, moist. Alterations of colour or texture. Eruptions. **Limbs:** peculiarities of form. Staggering gait. Spasmodic, twitching, or jerking movements. **Swelling:** local or general. Fluid or air in areolar tissue, in viscera, or cavities; circumscribed collections of fluid. Thickening. New growths, &c., painful or not.

* Excellent weighing machines may be obtained for £3 15*s*., of Messrs. Pooley, Fleet Street, London.

† These questions will sometimes enable the observer to ascertain the nature of the case at once. He will not write down the answers he receives, but the nature of his subsequent enquiries will be much influenced by the reply to these questions.

IV. POINTS TO BE DISCOVERED BY A MORE EXTENDED EXAMINATION.

Pain, Uneasiness, or Discomfort: local or general, its precise situation and character.

Pain *produced by pressure or by certain movements.*

Nausea, Vomiting, Rigors.

State of Intellect and Nervous System, Memory, Giddiness, Headache, Restlessness, Delirium, Impaired or Lost Sensation, Paralysis, Convulsions. Sensations of cold or heat, tingling, numbness, &c.; alterations in **Sight, Hearing, Smell, Taste, Touch.**

Appetite. Thirst. State of Tongue. Discomfort after Food.

Pulse, Respiration: their frequency and character.

Examination by Measurement,* Percussion, Palpation, Auscultation of Thorax, *Lungs, cavities of Pleura and Pericardium, Heart and large vessels;* **Abdomen,** *Liver, Stomach, Spleen, Colon, Bladder, &c.* Alterations in form or movements of these cavities.

Secretions and Discharges: *general characters.* Results of **Microscopical and Chemical** examination.

The blood.
Surface generally: sweat, sebaceous matter, cuticle.
Eyes: state of conjunctiva, canaliculi.
Nose: odour of breath, character of discharges.
Ears: secretion in external meatus.
Mouth: saliva, fur from the tongue, sputum, vomit.
Bowels: frequency and nature of discharge; quantity.

* Most measurements may be made accurately with an ordinary tape, marked with inches divided into eighths or tenths. In order to be sure that the tape is applied in the same spot, when measurements are made subsequently, spots may be made on the skin with nitrate of silver, ink, chalk, or various colouring matters, or by applying small pieces of black sticking plaster. These spots may also be marked on the plans of the figure, described in vol. ii, page 97, plates VII and VIII.

The respiratory movements may be measured with the stethometer of Dr. Quain, and the chest measurer of Dr. Sibson. Alterations in the inclination of different parts of the surface of the chest to each other, are to be ascertained by the instrument invented by Dr. Scott Alison (Archives of Medicine, vol. i, page 60).

Urine: frequency of micturition; accompanied with pain or not; general characters of the urine; quantity passed in twenty-four hours; specific gravity; microscopical and chemical examination; state of urethra, bladder, kidneys.

Catamenia: state of vagina, character and frequency of discharge. Leuchorrhœa.

Diagnosis:

Objects to be attained by treatment.

Treatment recommended: *the medicines ordered should be written in Latin, and the proportions denoted by the usual signs, but the directions should be given in English.*

All directions *as to diet and treatment should be underscored.*

The course of the case should be noted at regular periods. In many cases *every day or every other day* will be sufficient, but in cases of *acute disease*, notes should be made at *shorter intervals* (3 *to* 12 *hours*) according to the symptoms.

The frequency of the pulse and respiration, and the state of the principal secretions should be noticed day by day in acute cases.

PRINCIPAL TERMS USED IN REPORTING THE RESULTS OF PERCUSSION AND AUSCULTATION OF THE CAVITIES OF THE CHEST AND ABDOMEN.

By Palpation, Percussion, and Auscultation, alterations in the position, form, texture, and consistence of the viscera contained in the cavities of the chest and abdomen are ascertained.

PALPATION.

This word comes from the French *palper*, to feel. It means exploring by touch or feeling, or by applying pressure. The tips of one or more fingers may be employed, or the whole hand, according to the size of the space to be felt.

By palpation we are enabled to judge of the size, form, and consistence of tumors, which are not too deeply situated to be felt; the existence of fluid in certain cavities of the body. Pressure and movement of parts often cause pain, and thus we learn if sensation is diminished or exalted.

PERCUSSION.

In percussion, one or more fingers of the left hand are placed in contact with the skin, and as flat as possible over the region to be percussed, and the dorsal surface of one finger is to be struck sharply with the tip of the middle finger, or with the tips of two or three fingers of the right hand, the movement of the hand being produced at the wrist and not at the elbow joint. The exact spot over which a certain sound is elicited may be marked as described in the note on page 49.

Clear or resonant, as the sound produced by percussing those parts of the thorax which are situated over healthy lung.

Tympanitic or drum-like. The sound elicited by percussing the abdomen when the viscera contain air,—the thorax, when there is a large superficial cavity in the lung just beneath the surface, when the lobules of the lung are permanently dilated so as to form large simple sacs, as in *pulmonary emphysema*, or when the pleural cavity contains air (*pneumothorax*).

The **cracked-pot sound** occurs in some cases when sharp percussion is made over a cavity which is empty or contains only a little fluid, and communicates freely with the bronchial tubes. The patient should be made to open his mouth at the moment of percussion. This sound is not of very common occurrence.

Dull. The sound produced on percussing solid substances, somewhat modified according as it is produced by percussing over a thick layer of *fluid*, over *solid organs* as the liver, the thick muscular substance of the limbs or the bones.

All these sounds vary much in *intensity*, and considerably in *character*. The intensity of the dulness can be indicated in the plans by the darkness of the shading.

AUSCULTATION. THE LUNGS.

The ear may be simply applied to the walls of the chest covered with one thickness of linen; but for auscultation under the clavicles, and in some other parts of the chest, a stethoscope is not only desirable but necessary. By the latter instrument also, sounds occurring in circumscribed spaces are isolated, and to some extent separated from those occurring in the immediate neighbourhood.

1. Sounds produced by air passing to and from the air-cells of the lung.

Dry

Vesicluar breathing or *normal respiratory murmur* heard in health.

Puerile respiration, when the respiratory murmur is more intense than in health.

Feeble respiration, when the respiratory murmur is only slightly audible.

Prolonged inspiration or *expiration*, when the duration of the inspiratory or expiratory murmur is increased.

Rough, harsh, or coarse breathing, when the respiratory murmur is rougher than in health. When this modified respiratory murmur is

heard over a very small space, it indicates that a change has taken place in the character of the walls of some of the air-cells.

Moist

Fine crepitation. A fine crackling sound produced by the passage of small bubbles of air to or from the air-cells, through viscid fluid, or in consequence of the air-cells being diminished in size and their walls thickened from the pouring out of exudation.

2. Sounds produced by the air passing to or fro in air-tubes, or in cavities.

Dry

Rhonchus. A harsh, rough, or snoring sound, caused by the passage of the air along the larger bronchial tubes, when the mucous membrane is swollen or covered with viscid mucus, or when the calibre of the tube is diminished from any cause.

Sibilus. A hissing or whistling sound produced in the smaller bronchial tubes, under the same circumstances which give rise to rhonchus in the larger ones.

Bronchial breathing. A sound resembling that heard on listening over the trachea during respiration. When heard over a part of the chest, normally occupied by healthy lung, it may result from the air-cells of the lung being rendered solid by the accumulation of lymph and serum, tubercle, cancer, &c., and thus rendered a better conductor of the sound which is produced by the air as it passes along the larger bronchial tubes. This sound is often heard in pneumonia, tubercle, or cancer, but it may depend upon the pulmonary tissue being somewhat compressed and forced close to the parietes of the chest, as from the accumulation of fluid in the pleural cavity.

Cavernous breathing. A loud, harsh sound, produced by air rushing through a tube or dry cavity.

Amphoric breathing. The sound produced when air passes to or from a narrow orifice into a large cavity containing air.

Moist

Large Crepitation. Large or coarse crepitation, Mucous râles. Moist sounds, produced by bubbles of air passing through tenacious mucus or a viscid secretion in the larger bronchial tubes, or in small cavities.

Gurgling. A sound produced by the passage of successive bubbles of air through fluid contained in a tube or in a cavity.

Metallic tinkling. Probably caused by the sudden escape of a small bubble of air through fluid, or through a narrow opening into a cavity. It may be produced by moving the patient slightly, in a case where fluid and air exist in the pleural cavity.

3. Modified voice sounds.

Bronchophony. The voice sound modified by resounding in a tube or small cavity just beneath the walls of the chest, or separated from the surface by solid lung, resembling the sound heard by placing the ear a little below one or other sterno-clavicular articulation of a healthy person while speaking.

Pectoriloquy. Voice sounds modified by resounding in a large tube or cavity of considerable size, resembling the sound heard by placing the stethoscope over the larynx of a healthy person when speaking.

Ægophony. A curious trembling, twanging sound, something like the bleating of a goat, generally produced by the voice sounds passing over the surface, or through a thin layer, of liquid in the pleural cavity.

Cough. When the patient is made to cough, many of the respiratory sounds are greatly increased in intensity, and during the long drawn, forcible inspiration which succeeds, crepitation may be produced, which does not occur in ordinary breathing.

4. Friction sounds, produced by the rubbing together of two rough surfaces.

Pleuritic rubbing. This may accompany inspiration and expiration, but when slight may be audible only at the end of a forced inspiration. It is described as a creaking, grating sound. It may have a dry or moist character.

To and fro rubbing or friction sound, heard over the region of the heart in pericarditis, caused by the rubbing together of the layers of the pericardium, upon which lymph has been effused.

The grating thus produced, which is audible by the ear, may often be felt by the hand in pleurisy and in pericarditis. In peritonitis, if the abdominal walls be moved a little with the fingers applied flat to the surface a peculiar rubbing is felt.

AUSCULTATION. THE HEART.

The heart may be examined by percussion and auscultation. The sounds produced by its action may be listened to in front, at the side, or at the back of the chest.

Position of the heart determined by percussion.

Impulse of the heart increased or diminished.

Rythm. Note any alterations in the duration of the sounds, or interval. *Irregular* or *intermittent* heart's action. Any alterations in the character or intensity of the first or second sounds should be noticed. They may be clear, or dull, or muffled.

Murmurs, *bruits or bellows' sounds, sawing, blowing, musical, cooing.* A bruit heard most distinctly at the base of the heart, may be situated in the *aorta* or *pulmonary artery*, and may take the place of the first or second sound of the heart. Bruits are caused by narrowing of orifices, or by some deficiency of the valves which guard them. In the case of the aorta and pulmonary artery, a *systolic bruit* is produced by a narrowing of the orifice, a *diastolic bruit* arises from a defect in the closure of the valves.

A systolic bruit is often heard over the aorta, and in the course of the large arteries in cases of anæmia, where there is no change whatever, either in the orifices or in the valves.

Venous murmur. In similar cases, a continuous humming or purring sound is often heard by placing the stethoscope *lightly* over the large veins at the base of the neck.

A bruit, heard most distinctly at the apex of the heart, generally depends upon a defect in the closure of the mitral valve. It is *systolic* and *regurgitant,* depending upon the blood flowing from the ventricle back again into the auricle during the systole.

CHEMICAL AND MICROSCOPICAL EXAMINATION OF SECRETIONS.

CHEMICAL APPARATUS AND RE-AGENTS.

Nitric Acid.
Sulphuric Acid.
Acetic Acid.
Solution of Potash.
Solution of Soda.
Ammonia.
Solution of Chromic Acid.
Nitrate of Silver.
Nitrate of Barytes.
Phosphate of Soda.
Oxalate of Ammonia.
Iodine Solutions.
Sulphate of Magnesia.
Tincture of Galls.
Alcohol.
Ether.
Sulphate of Copper.

Apparatus.—*Glass Slides, Thin Glass, Pipettes, Conical Glasses, Spirit Lamp, Small Retort Stand, Test Tubes, Stirring Rods, Filters and Filtering Paper, Beakers, Evaporating Basins, Small Water Bath, Urinometer, Blue Litmus Paper, Red Litmus Paper.*

The tests may be kept in bottles or in tubes with capillary orifices.

MICROSCOPE AND INSTRUMENTS.

CLINICAL MICROSCOPE.

Clinical pocket microscope.* The powers required are the quarter, magnifying about 200 diameters, and the inch, magnifying about 40 diameters. Needles mounted in handles. Scissors, forceps, animalcule cage for examining urinary deposits, &c., glass slides, thin glass.

Glycerine for preserving specimens. When a specimen is to be preserved in glycerine, it is to be immersed in the fluid for some hours before it is mounted permanently.

MICROSCOPICAL EXAMINATION.

⁎ References are given to "The Microscope in its application to Practical Medicine," second edition.

In the microscopical examination of the various secretions and discharges, the observer must constantly bear in mind that various extraneous matters are likely to be present. It is also necessary to be aware that cases of imposition are of very frequent occurrence. The observer should make himself familiar with the microscopical characters of the ordinary articles of food, and the deposits from drinks, as soon as possible, or he will be liable to make the most ludicrous mistakes. *Mic. in Med., p.* 297.

Sebaceous matter. Oil globules, granular matter, fragments of hair, sometimes crystals of cholesterine. In that from the follicles of the

* The instrument is made by Mr. Matthews, opposite King's College Hospital, and Mr. Highley 70, Dean Street, W.

nose, ears, and scalp, the *entozoa folliculorum* are found. These entozoa are very common, and are found in the upper as well as in the lower classes. They are examined after the addition of a drop of oil or glycerine.

Cuticle. *Epithelial scales* as modified in skin diseases. *Fungi* are present in various diseases. To be demonstrated by soaking cuticle in glycerine, and examining with a power of 400 diameters or higher. *Mic. in Med., p.* 245, 369.

Contents of vesicles, pustules.

Conjunctiva. Tears. *Epithelium*, form.

Nose. *Mic. in Med., p.* 253. *Mucus from Nose, p.* 274. *Epithelium.* Squamous, ciliated, black particles of carbon. *Pus corpuscles.*

Ears. Oil globules, fragments of hair, granular matter. *Entozoa folliculorum* in wax. *Fungus* rarely observed. *Mic. in Med., p.* 373.

Mouth. *Saliva. Salivary corpuscles. Epithelium* from mouth often invaded by fungi. *Mic. in Med., p.* 265. Fur from the tongue usually consists of epithelium and the débris of old epithelial particles, oil globules, and various insoluble constituents of the food, granular matter, and minute fungi.

False Membranes on back of tongue and pharynx. *Mic. in Med. p.* 278, 281.

Sputum. Small pieces should be taken from different parts of the sputum, and subjected to examination separately. It is only necessary to place a piece about the size of a pin's head on the glass slide, and cover it with thin glass, pressing it until sufficiently thin to be transparent. If it is necessary to moisten it, it is better to use weak glycerine than pure water.

Mucus contains small and large granular cells, large spherical masses containing particles of carbon, and occasionally cells of columnar epithelium from the bronchial tubes.

In catarrh, the granular cells are more numerous and more closely resemble pus corpuscles. In the opaque yellow sputum of chronic bronchitis, pus is very abundant.

The viscid rusty sputum of pneumonia contains numerous small granular corpuscles, the cells found in ordinary mucus, blood corpuscles, and often much fine granular matter.

In phthisis, pus is often present in considerable quantity. Occasionally tubercle corpuscles may be observed, and sometimes small fragments of pulmonary tissue. The latter prove that softening is taking place, and the pulmonary tissue disintegrating. Care must be taken not to mistake the fibrillation of mucus for the elastic fibres of pulmonary tissue. *Mic. in Med., p.* 277. Besides these structures, mucus cells, much granular matter and oil globules.

Vegetable structures are often present in sputum. *Mic. in Med., p.* 281.

Fibrinous casts, masses of calcareous matter, portions of hydated cysts, and *fragments of echinococci,* are met with in rare cases.

In all sputum the observer will meet with fragments of the epithelial covering of the mouth and tongue, and various substances taken in the food, oil globules, starch granules, fragments of muscular fibre, and

numerous other bodies, with the microscopical characters of which he must make himself familiar. *Mic. in Med., pp.* 297, 180, *&c.*

Vomit. *Epithelium from the tongue, mouth, œsophagus,* or *stomach,* may be present. Small fragments of various articles of food are constantly found. Very often large oil globules, in which the stearine has crystallized, are met with. *Blood corpuscles.* Various forms of *fungi. Sarcinæ.*

The superficial layers of the epithelial covering of the œsophagus are sometimes expelled in the form of a tube, and large flakes of the epithelium of the stomach have been rejected. *Mic. in Med.. p.* 283.

Discharges from the bowels. *Epithelium* from the large intestine, with flakes of mucus. Sometimes large flakes of the epithelium are passed entire. Blood corpuscles, when present, are often very much altered. In cholera, the epithelium from the small intestine, and complete sheaths of villi and casts of the follicles have been found, but are not constantly present. Fungi of various forms are occasionally found. Numerous substances derived from the various articles of food which have escaped the process of digestion. Pieces of yellow elastic tissue from the arteries or from the ligamentum nuhæ, are often found, and have been mistaken for entozoa. *Mic. in Med., p.* 284.

Discharges from the uterus or vagina. Menstrual fluid contains blood corpuscles, many of which are ragged and much altered, and epithelium from the uterus and vagina. Casts of the epithelial covering of the vagina are sometimes passed entire. *Mic. in Med.,* p. 286.

Leucorrhœal discharge usually contains pus, modified epithelium from the vagina, and the usual large epithelial scales. *Mic. in Med.,* p. 308. The trichomonas vaginæ has been found by some observers. *Mic. in Med.* p. 308.

Cancer cells are sometimes found in cases of cancer of the uterus or bladder. *Mic. in Med.* p. 286.

URINE.

*** The references are to the Author's work on "*Urine, Urinary Deposits, and Calculi.*"

For instituting a rough general examination of a specimen of Urine. The most necessary tests may be arranged under six heads; and, by having recourse to one or more of these, we are enabled to determine roughly the most common morbid states of the urine.

1. *Reaction* (pp. 12, 82, 83).

2. *Specific Gravity* (pp. 8, 10, 81). When very high, we may suspect an increased quantity of urea (excess); the presence of sugar. Apply tests mentioned below. Hysterical urine, and urine of cases where much water has been taken, is of very low specific gravity.

3. *Heat.* Urate of ammonia, distinguished from pus or phosphate (p. 275). Albumen. Precipitation of phosphate, etc. (p. 134).

4. *Nitric Acid* dissolves phosphates (p. 134); decomposes urate of ammonia (if strong, rapidly); precipitates albumen in urine, even when in very small quantity, and due to the presence of pus. Used also to test the presence of uric acid. Excess of urea. Bile (p. 144).

5. *Potash* (274). Urates are soluble in potash, and are thus distinguished from pus or phosphate. Uric acid from blood corpuscles. Sugar indicated by a brown colour, after prolonged boiling.

6. *Nitrate of Silver* (p. 59). Precipitate of chloride of silver, insoluble in nitric acid. In certain cases of extensive inflammation, as in pneumonia, pleurisy, and some others, the urine does not contain a trace of chloride of sodium (p. 108).

1. Chemical examination with reference to detecting the nature of the deposit.

a. Light and flocculent deposits. Deposits of this class are generally too light, and the quantity is too small for the application of chemical tests. See *microscopical examination* of deposits, below.

b. Dense and opaque deposits, usually present in considerable quantity, are of three kinds, which much resemble each other in appearance.

1. *Urate of Soda* (p. 274). Lateritious, nut-brown sediment. Varies much in colour. Urine acid. *Tests.* Soluble by heat, in potash, ammonia, water. Decomposed by acid; uric acid set free.

2. *Phosphates* (p. 283) Urine usually alkaline or neutral. When triple, phosphate alone is present, the urine is sometimes feebly acid. *Tests.* Insoluble by heat or in alkalies; soluble in acids, and afterwards precipitated by ammonia.

3. *Pus* (p. 278). Diffused through the urine, rendering it turbid, or forming a bulky creamy deposit, with clear or turbid supernatant fluid *Tests.* Rendered glairy by potash. Albumen in urine precipitated by heat and by nitric acid. *Caution.* Albumen *may* be independent of the pus.

c. Crystalline or granular deposits are usually in small quantity, forming a sediment which may either be coloured or transparent and colourless.

1. *Uric acid* (p. 291). Colour characteristic, usually of a dark mahogany brown, sometimes paler, very seldom quite colourless. Large separate clusters of crystals. It rarely forms a granular deposit. *Tests* (p. 295). Soluble in potash, nitric acid. After evaporation with nitric acid, ammonia gives the dark violet colour of murexide or purpurate of ammonia. Often mixed with blood, smoky urine. Albumen detected in the fluid. 2. *Blood corpuscles* (p. 313). See *microscopical examination.* 3. *Oxalate of lime* (p. 297). Seldom in sufficient quantity to form a deposit visible to the unaided eye. See *microscopical characters. Tests for oxalate of lime calculi.* Insoluble in water, potash, and acetic acid, even when boiled; soluble in mineral acids; and again thrown down amorphous, but unchanged in composition, by ammonia. By incineration, an odour like that of burnt feathers is evolved. Black ash becomes white by decarbonization; this ash is soluble in acetic acid, with copious effervescence. Oxalate of ammonia added to acetic acid solution precipitates oxalate of lime.

4. *Silica* (p. 313) is said to have been found in very minute quantities in urine; rarely met with as a deposit, except in the form of grains of sand in the urine of hysterical patients and impostors. Easily known by its great density, general appearance, and insolubility in strong mineral acids.

2. Chemical Examination with reference to the Discovery of an Abnormal Condition of the Soluble Constituents of the Urine, or of the Existence of Substances of a Soluble Form not met with in Health.

1. *Albumen* (p. 131). Urine pale; often of very low specific gravity, 1005 to 1012 or 1014. Heat or nitric acid, if urine be acid; nitric acid, if the urine be alkaline. Reason: solubility of albumen in alkalies. *Fallacies.* A *trace of nitric acid* prevents the precipitation of albumen by heat (p. 134). Precipitation of phosphates by simply boiling the urine. Precipitation of minute crystals of uric acid upon the addition of dilute nitric acid to some specimens of urine: hence necessity for employing both tests (p. 134).

2. *Excess of Urea* (p. 89). Urine frequently high coloured; specific gravity, 1030 to 1040. Upon the addition of an equal volume of strong nitric acid, crystals occur within half an hour, if there be much excess. Oxalic acid is often employed when the urea is to be determined quantitatively.

3. *Sugar* (p. 148). Urine pale, of high specific gravity, from 1030 to 1050. Trommer's test (p. 151). Potash tests (p. 151). Fermentation test (p. 160). Tartrate of copper (p. 152).

4. *Sulphates* (pp. 56, 113). Nitrate of barytes or chloride of barium, after the addition of a few drops of nitric acid.

5. *Chloride of Sodium* (pp. 59, 108). Nitrate of silver, after the addition of a few drops of nitric acid.

6. *Bile* (p. 144). Urine of a dark yellow colour. Nitric acid; play of colours. Pettenkofer's test.

Microscopical Examination of Urinary Deposits.

Great caution required in every step (p. 212). A large quantity of urine (at least four ounces) should be allowed to subside in a *conical glass* (Figs. 87, 90) for some (two or three) hours, or the greater portion of the urine may be poured off from the deposit, which may then be submitted to examination. In this case, small bottles only need be taken to collect specimens; but, of course, no idea can be formed as to the relative amount of deposit present (p. 212). When the insoluble matter has subsided, the deposit may assume one of three characters.

1. It may occupy a large bulk, and present a flocculent appearance; or
2. It may form a dense, opaque, abundant or scanty stratum; or
3. The deposit may be small in quantity, crystalline, consisting of sparkling colourless points, or of granules more or less coloured.

All these characters may co-exist in one deposit, in which case we observe three distinct strata, each of which must be *separately* submitted to microscopical examination. In most cases, there are two distinct strata.

1. *Substances floating on the surface of the Urine, or diffused through it, but not forming a visible Deposit.*

a. Opalescence produced by urates (p. 233).
b. Opalescence produced by vibriones (p. 233).
c. Milk in urine (p. 234).
d. Chylous urine (p. 234).

2. *Deposit light and flocculent, occupying a considerable Bulk.*

Always take specimens from the bottom of the glass for examination, as well as from the bulk of the deposit.

a. Simple mucus-corpuscles (p. 253), or with bladder or renal epithelium (p. 259). Cells sometimes tinged with yellow bile.

b. Simple mucus, or *epithelium,* with numerous small crystals of oxalate of lime entangled in it (p. 597).

c. Casts. Various forms of casts (p. 263). *α.* Casts of medium diameter. *β.* Casts of considerable diameter. *γ.* Casts of small diameter.

d. Vibriones (p. 256). Torulæ (p. 257). Spermatozoa (p. 260). Sarcinæ (p. 258).

e. Matters of extraneous origin (p. 225). Bed-flock : hair : feathers : dust. Distinction from casts, etc. (p. 229).

3. *Deposit dense, opaque, and abundant.*

a. Urates. Amorphous deposit soluble by heat.

b. Pus (p. 278). Characters. Rendered glairy by potash. Action of acetic acid on the pus corpuscles as shown in microscopical examination.

c. Phosphates (p. 283). Phosphate of lime (amorphous) (p. 284). Triple or ammoniaco-magnesian phosphate (crystalline) (p. 283). Mixed with carbonate or oxalate of lime.

d. Sand. Starch (p. 229) Potato : rice : bread-crumbs : arrowroot.

4. *Granular or crystalline Deposits, small in quantity, sinking to th bottom, or adhering to the sides of the vessel.*

a. Uric acid (p. 293). Forms of. Amorphous. Varies much in colour. Polarisation.

b. Oxalate of lime (p. 297). Forms of. Dumb-bells. Distinction of oxalate of lime from triple phosphate.

c. Phosphate of lime (p. 284). Triple phosphate, radiating crystals p. 283).

d. Blood-globules (p. 313).

e. Cystine (p. 176). Carbonate of lime (p. 312 .

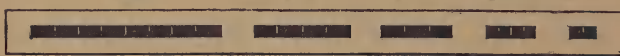
SUGGESTIONS FOR MAKING AND RECORDING POST-MORTEM EXAMINATIONS.

The different organs may be examined in any order, and in many cases it is only possible to examine those which are considered to be in a morbid state, but, where time is allowed, the following order is recommended.

Notes should be made at dictation, in a book kept for the purpose, while the body is being examined. The observations should soon afterwards be entered in their proper order, in the **Post Mortem Book**, and the results of the more minute microscopical and chemical examinations which may be necessary, added. The **Rough Notes** taken at the time should always be carefully preserved.

Loose comparisons as to form, dimensions, bulk, colour, weight, specific gravity, consistence, &c., should never be permitted. Form and colour should be indicated by sketches with coloured chalk. Size in eighths or tenths of an English inch.

1 In. ½ in. ⅜ In. ¼ In. ⅛ In.



I. TO BE NOTED BEFORE COMMENCING.

Date and Time of Examination. *Weather, Temperature.*

Name, Age, *or apparent Age. Sex.*

Date of Death of Patient. Reference to Case Book.

Measurement of Body. *Height, Weight, Nutrition.*

Cadaveric Rigidity. *Putrefaction, Temperature of Body.*

External Appearances. Expression of countenance, Peculiarities and Colour of Hair, Colour of surface generally. *Œdema, Emphysema.*

II. EXAMINATION OF HEAD AND SPINE.

The head is to be opened as follows:—An incision is to be made through the integuments of the scalp, down to the bone, from ear to ear. The flaps are to be drawn *forwards* over the face, and *backwards* over the neck. The saw is to be carefully carried round the head, an inch above the eyebrows in front, and through the occiput behind.*

* The best saw for the purpose is a bow saw. A chisel-shaped instrument, of a T shape, is most convenient for wrenching off the calvarium, when sawn through. A very thin long knife is required for removing the brain in slices. A tin can with a spout, having an orifice of rather less than a quarter of an inch in diameter, is the most convenient vessel for pouring a stream of water upon the brain, to ascertain its consistency.

Integuments of Cranium, Bones of the Skull, Dura Mater. State of the Sinuses, Pacchionian bodies, Character of **Arachnoid,** Fluid seen upon opening the dura mater, Surface of Brain, Vascularity, Firmness of convolutions, Width of convolutions and of the sulci between.

The brain is to be removed by dividing the nerves at the points where they leave the dura mater. The tentorium cerebelli is to be divided with the point of the knife, and the medulla oblongata, with the vessels, are to be cut across as low down as possible.

Brain. *Weight, General Vascularity, Consistence, Specific Gravity ; its bulk.**

Remove hemispheres by horizontal slices ; notice—

Extravasations of Blood, *Dilated Vessels,* **Tumors,** *Soft Patches, Cicatrices, Vascularity, Firmness, Moisture of White and Grey Matter.*

Lateral Ventricles. *Quantity of Fluid in them, Lining Membrane, Choroid Plexuses, Velum Interpositum, Fornix, &c.*

The corpora striata and optic thalami are to be removed gradually, in thin slices cut vertically, inclining outwards. Each slice should be carefully examined for cicatrices of clots.

Corpora Striata, *Pineal Body.* **Corpora Quadrigemina,** *Processus e cerebello ad testes.*

Pons Varolii, *or Mesocephale.*

Medulla oblongata. Surface, Section, *Fourth Ventricle.*

Cerebellum.

These parts are likewise to be removed by thin slices.

The laminæ of the vertebræ are to be sawn through or cut through with a proper instrument. The nerves are to be divided as they pass through the intervertebral foramina, and the spinal cord may be removed.

Vertebræ, Dura Mater. *Spinal Veins.*

Cerebro-spinal Fluid. *Arachnoid, Pia Mater.*

Spinal Cord. *Weight, Dimensions, Consistence, &c.*

Sections of Cord. Roots of the Nerves.

* The bulk of an organ is ascertained by measuring the exact quantity of water it will displace.

The microscopic examination of the spinal cord is conducted according to the plan recommended by Mr. Lockhart Clarke.—Archives of Medicine, vol. iii, p. 22.

Examination of Eyes, Nose, Ears.

III. EXAMINATION OF THE THORAX, ABDOMEN, AND PELVIS.

An incision is to be made through the integuments, from a point three inches beneath the chin to the pubis. The linea alba being divided, the skin and muscles may be dissected from the thorax, and the abdomen laid open, by forming two longitudinal flaps. There is no necessity for cutting through the abdominal walls transversely. The cartilages of the ribs are to be divided with a strong knife, or with bone forceps, and the sterno-clavicular articulation cut through. The front of the sternum may now be removed, care being taken not to injure the large veins or pericardium.

Fluid in Pleura or Pericardium. *Quantity,* Adhesions.

Observe the position and relative size of the viscera, lungs, heart, liver, stomach, spleen, colon, small intestines, &c. Position and general appearance of tumors **in situ.**

Cut through the large vessels at the base of the neck and divide the trachea immediately below the cricoid cartilage, or, when permitted, dissect away the tongue from its attachment to the ramus of the jaw, draw it down, and remove it with the pharynx, œsophagus, larynx, &c. The larynx and pharynx being firmly grasped, the lungs are to be carefully torn away from their attachment to the spine. The large vessels and the œsophagus are to be divided immediately above the diaphragm. Often it will be found most convenient to remove a portion of the diaphragm attached to the pericardium. Lungs, heart, trachea, larynx, and œsophagus are then to be removed.

Lips. Fauces, Uvula, Tonsils, Teeth, Pharynx.

Tongue. Epiglottis, Glottis, Œdema, *Foreign bodies in the Larynx or Trachea.*

Larynx, *Trachea.*

Trachea and bronchi to be opened by an incision in front. Avoid wounding the œsophagus.

Lungs. *Colour, Consistence, Weight, Density.* Do they sink in water, or does any part of them sink?

Section. *Cavities,* Extravasation of Blood, Deposits in pulmonary tissue, cysts, &c.

Diaphragm.

The heart may now be separated from the lungs, by dividing the root of each close to the lung.

Position of Heart in Thorax. *Relations.*

Pericardium. External surface, internal surface.

Heart. *Adhesions in Pericardium, Size, Weight,* Fat about Heart, Capacity of Ventricles.

Measure the quantity of fluid they will contain, and ascertain if the valves completely close the orifices, by pouring in water.

Open the right ventricle. By making an incision near the septum, and, by carrying another along the right edge, a V-shaped flap may be formed. Examine the tricuspid valves. Next pass the finger into the infundibulum and pulmonary artery, which is then to be laid open, by carrying the incision onwards between two of the valves. Dissect the pulmonary artery from the aorta.

The left ventricle is to be opened by an incision directed towards the aorta, commencing near the apex of the heart, a little to the left of the septum. The aorta is to be divided between two of the valves and the arch is to be slit open.

Examine auricles and large veins, clots in heart, state of the walls of the cavities, interior of heart, size of *auriculo-ventricular orifice of right side, size of orifice of pulmonary artery,* **tricuspid valve, semilunar valves of pulmonary artery,** *auriculo-ventricular opening of left side,* **aortic orifice, mitral and semilunar valves,** ascertain how many fingers are admitted through the valvular orifices in the heart.

Aorta. *Its diameter,* character of coats, hardness, dilatation, aneurisms.

Coronary Arteries.

Note any points, with reference to the viscera, while they remain in situ. Remove liver with stomach and intestines, spleen, &c. Carefully tear the colon away from its attachments and divide the rectum at its commencement in the sigmoid flexure. In this dissection be careful not to injure the genito-urinary organs.

Œsophagus.

Peritoneum generally.

Mesenteric Glands.

Stomach. Size, *Contents,* Condition of Mucous Membrane, Muscular Coat, Pylorus.

Next the common biliary duct is to be examined. The duodenum may be opened and probes passed into the gall and pancreatic ducts, which may then be traced in their course from the glands to the intestines.

Coats of Gall and Pancreatic Ducts. Mucous Membrane, Gall stones, Pancreatic concretions.

Separate the small intestines from the mesentery, and afterwards slit them up with scissors, close to their mesenteric attachment, in order to avoid dividing Peyer's patches. The mucous surface is to be carefully washed by a gentle stream of water.

Duodenum. *Valvulæ conniventes,* Vascularity, **Brunner's Glands.**

Brunner's glands are situated in the submucous areolar tissue, and must be exposed by inverting the duodenum upon a loaded cork under water, when, the serous and muscular coats having been removed, the glands are observed and may be isolated, by dissecting away the areolar tissue.

Jejunum, Ileum. Valvulæ conniventes, Vascularity, *Peyer's patches.*

Cœcum. *Ileocœcal valve, Appendix Vermiformis.*

Colon. Condition of Muscular Coat, *Solitary Glands.*

Rectum. *Hæmorrhoids.*

Liver. Adhesions, *Bulk, Weight, Density, Hardness,* Colour, *Capsule, Portal Canals.*

Structure of Substance of the Organ. *Congestion of Portal or Hepatic Veins.*

A thin section of the liver should be placed upon a piece of glass and held up to the light, when the minute branches of the portal vein may be seen at the circumference of the lobules and the little twig of the hepatic vein in the centre. This is often divided in making the section.

Gall Bladder.

Bile. Colour, Re-action, Density, Microscopical characters.

Spleen. *Size, Weight,* Colour, Consistence.

Pancreas.

The kidneys, with the ureters, bladder, and lower part of the rectum should be removed together. In the male the testicles and penis can be taken out at the same time. In the female the ovaries, uterus, and Fallopian tubes may be removed with the kidneys and bladder, and each organ examined separately.

Kidneys. *Capsule,* Surface when capsule removed, Size, Weight, *Cortical structure, Medulla, Pelvis of Kidney, Ureter.*

Bladder. Contents of Bladder.

Male. *Urethra, Penis, Prostate, Testicles.*

Female. *Urethra, Vagina, Hymen, Uterus, Ovaries, Breasts.*

Large Arteries and Veins of the Abdomen. *Coats, Coagula.*

Ganglia and Plexuses of Sympathetic.

IV. EXAMINATION OF THE LIMBS.

Size, *Form, Muscles, Nerves, Joints, Bones.*

Appearances resulting from Post Mortem Change.

The walls of the large vessels and other structures are often stained, from mere contact with the blood. This post mortem change must not be mistaken for inflammation or congestion occurring during life. In congestion the distended capillaries can always be distinguished by the use of a lens. There are also many changes in texture, resulting from infiltration of serum; and of colour, depending upon the action of gases set free after death, and upon other causes, which must be carefully noted and not mistaken for the results of diseased processes.

MICROSCOPIC EXAMINATION.

The specimen to be examined must be immersed in fluid. As a general rule, glycerine of various strengths will be found most satisfactory. The tendency of glycerine to render tissues too transparent may, in great measure, be counteracted by the addition of a little alcohol or chromic acid. Morbid specimens often undergo change more rapidly than healthy tissues. It is therefore of the utmost importance that the examination should be proceeded with as soon as possible.

Thin sections of tissues are easily made with a thin double-edged knife. In making thin sections, the knife must be wetted with water or glycerine.

It will be convenient to keep a few glass slides, with thin glass ready for making rough microscopical examinations, in the post-mortem room. This may be readily effected by using the clinical pocket microscope shown in page 54.

Part II.

ORIGINAL RESEARCHES IN PHYSIOLOGY AND MORBID ANATOMY.

ON THE HISTOLOGY OF A RECURRING FIBROID TUMOUR.

By Wm. Roberts, M.D., Lond.
Physician to the Manchester Royal Infirmary.

PLATE III.

Emma Murray, æt. 38, a domestic servant, was admitted into the Manchester Royal Infirmary, under the care of Mr. Smith, March 25th, 1861.

The patient applied on account of a large tumour, situated in the upper part of the neck, immediately beneath the ramus of the jaw, on the right side.

The tumour was rounded in shape, and smooth on the surface, showing, however, indistinct division into lobes. When first perceived, about ten years ago, it was about the size of a marble, and occupied the site of the right submaxillary gland. It enlarged gradually without pain, or other inconvenience, except that occasioned by its bulk. In the last twelve months its growth had been more rapid, and at the time of the patient's admission the tumour was as large as a child's head. The skin over it was loose, pale at the upper part, and somewhat florid at the lower part. The tumour seemed unattached to the deeper structures. It felt highly elastic, and communicated so deceptive a sense of fluctuation that Mr. Smith, a fortnight before its removal, passed a trocar into its substance; but only a few drops of blood trickled through the canula. The wound healed perfectly in a day or two. None of the lymphatic glands in the neighbourhood were enlarged, and the patient, though spare, was in perfect health.

On the 17th of May, Mr. Smith proceeded to remove the tumour. The operation was performed without other difficulty than that arising from the wounding of a large vein, which

bled profusely, and was secured with considerable trouble. The tumour proved to be wholly detached from the surrounding tissues, and to be devoid of a pedicle. The skin was brought over the formidable chasm where the tumour had lain, by sutures in the usual way, and rapid recovery, without any bad symptoms ensued.

Naked eye appearances of the tumour.—It was as large as the head of a new-born child. A moderately thick capsule of fibro-cellular tissue invested it. This could be peeled off from the surface of the mass as easily as the tunica propria from the kidney. Numerous vessels ramified on its surface. One lobe as large as an apple, and three small ones gave some irregularity to an otherwise spherical outline.

When divided hemispherically the cut surface appeared uniform, of a pale gray colour; and the little blood that oozed from it showed but a scanty vascularity. The track of the trocar was easily followed along a buff-yellow band, that terminated about the centre in a patch of extravasation. Besides this there was no sign of hemorrhage into the tumour, nor of degeneration in any part of it. Its substance was soft, breaking down easily under the nail, and presenting an appearance strongly reminiscent of encephaloid cancer.

On closer examination the surface had a somewhat glandular look. It appeared divided into areas or lobules, about the size of a pea. These lobules were indistinctly insulated, and the exceeding friableness of the texture forbad the idea of a really glandular structure. Perhaps, that a better notion of the appearance of the surface would be conveyed by comparing it to that of a sore covered with pale, flattened, œdematous granulations.

No juice exuded from it when compressed; and when a thin section was placed on a glass slide for microscopical examination, it had somewhat the appearance of boiled white of egg; it broke up easily under the pressure of the blade of the scalpel and did not exhibit any of the tenacity of fibrous tissue.

Under the microscope its structure came out with great clearness. *First* (see Plate III, fig. 1), were recognized oval vesicular bodies of exceedingly pale aspect, containing usually two, sometimes one bright granule, imbedded in a faintly molecular material. If two granules were present, they occupied the opposite ends of the cell. These bodies resembled, in their general aspect, the oval sporules of the penicillum glaucum found in urine, but had a paler, fainter appearance. They varied in size from $\frac{1}{1500}$ to $\frac{1}{3000}$ of an inch. A few of them were reniform, and cell multiplication by fission could be occasionally

traced. Although evidently vesicular, they resembled nuclei in their insensibility to acetic acid, and in the presence of nucleoli. Very few of them were spherical; the great majority being a more or less lengthened oval. I had no difficulty in identifying them with the so-called nuclei described and figured by Mr. Paget, and Dr. Bennett, as having been found by them in recurring fibroid and fibro-nucleated tumours.

Secondly. (See Plate III, fig. 2.)—Numerous tailed and branched cells were also observed. Some of these had one prolongation; others two at opposite poles, presenting the well-known spindle-shape; others again were multipolar. The caudate prolongations were occasionally observed to be split up at their extremities into a bunch of fine fibres. In other instances the caudal appendage of one cell became continuous with the caudal appendage of another cell; and sometimes several cells were placed in continuity with each other by means of fine branches which joined together. Some portions of the tumour were entirely made up of a confused assemblage of these spindle-shaped and branched cells.

Thirdly. (See fig. 3.)—In other places there was seen a mass of very delicate fibres, netted into an intricate interlacement, in the meshes of which lay a number of the oval cells already described. On a closer examination, some of the fibres appeared as thicker tracts from which the finer filaments ramified in an arborescent fashion. Some of these thicker tracts had a firm appearance, and refracted the light strongly; and from their ends and sides sprang an infinite number of delicate branching lines like the rootlets from an under-ground stem.

Intermediate forms were found representing all the gradations of change between the oval cell and the tangled mass of fibres. It was impossible to resist the conclusion that the latter was the ultimate development of the former.

The intercellular substance was hyaline and structureless, devoid of any traces of fibrillation, and therefore altogether unlike that of the ordinary forms of white fibrous tissue. Bright molecules, and in some places minute fat globules, lay scattered through it. It appeared most abundant where the oval cells were most numerous and least changed, and least abundant where the tissue was composed most largely of the branched cells and their anastomosis of capillary prolongations.

The structure of this tumour then, if I have interpreted the appearances aright, stands midway between white fibrous tissue, yellow elastic tissue, and cartilage. It resembles the last in its hyaline intercellular substance, but differs from it in the

branching of its cells.* Its resemblance to yellow elastic tissue must be considered very marked if we accept the view of Donders respecting the histology of that tissue. Donders believes that elastic tissue is composed of a close ramification of branching cells, in the central parts and prolongations of which an elastic material has been deposited, giving thickness and elasticity to the fibres; while intercellular substance is almost altogether absent. In this tumour, or at least in what may be regarded as the most developed portions of it, there was found a tissue of fibrous appearance, evidently constructed of ramifying cells; and in some spots a stronger refraction of the light and increased thickness of the fibres, seemed to indicate a commencement of deposit within the cell-prolongations. But the fibres generally were excessively delicate and soft, offering a contrast rather than a resemblance to those of elastic tissue.

With white fibrous tissue, the present growth agreed in the possession of stellate communicating cells of delicate organization; also in the presence of a considerable amount of intercellular substance, but it contrasted notably in the total absence of any fibrillation of the latter.

The clinical history and anatomical relations of this tumour are sufficient of themselves to remove it from true cancerous growths; but it is equally removed from them by its histology. The absence of cancerous juice and of any traces of fibrillation in the intercellular substances, together with the form and development of the cells, indicate a distinct separation from malignant growths.

I have not hesitated to class this growth with those designated "recurring fibroid" by Mr. Paget. It agrees with them in its general naked eye characters, in not affecting the adjacent lymphatic glands, and in being wholly unattached to the surrounding tissues. It agrees, likewise, in the total absence of constitutional symptoms, although the tumour had been steadily progressing for ten years. Its history lacks, of course, the characteristic singled out by Mr. Paget as a basis of nomenclature because it is the first of its kind removed from the patient. Will it return? Judging by what is known of such growths, the answer must be in the affirmative; but hitherto, so far as I know, no sample of this tumour has been

* Mr. Paget has described at p. 188 of vol. ii, of his Lectures on Surgical Pathology, a tumour not unlike the present, but having stronger affinities with cartilage. It consisted of a viscid soft intercellular substance and a number of large cells; some oval or round, others branched, and two cells are represented as being connected by the fusion together of a prolongation from each.

recognized on the first removal. It is open to question, therefore, whether, inasmuch as in some four examples, already on record, the recurrence took place but once, and was then followed by permanent immunity, there may not be cases of complete recovery after the first removal.

If the view here propounded of the minute structure of these rare growths be substantiated, their varying consistency, and their similarity or dissimilarity to true fibrous tumours will probably be found to depend on the relative proportion of the cellular element to the intercellular substance. When the latter is abundant, the tumour will be soft and brain-like; when the former is in excess, the growth will be firm like ordinary fibrous tumour.

Mr. Paget found that, in a very large proportion of the cases seen by him, recurring tumours occurred in cancerous families; and he entertains the opinion that such tumours often represent what may be called a gradual fading of the cancerous diathesis. He believes that it will be found, that among the members of families in which cancer has occurred, there is a peculiar liability to the production of tumours which will recur after repeated and complete excisions, though they are neither cancerous in structure nor attended with disease in the lymphatics and other organs. "If this can be proved we may justly hold that this character of recurrence indicates the existence of the cancerous diathesis, either with less abundance or less concentration of material than is required for the production of a cancerous tumour with all the typical properties."*

In the present instance there is no evidence of hereditary taint. The patient's mother died of phthisis, and her father of old age. None of her relations in any degree are *known* to have suffered from any species of tumour or morbid growth.

* Mr. Paget. Medical Times and Gaz. Aug. 22, 1857.

LECTURES

ON THE

STRUCTURE AND GROWTH OF THE TISSUES

OF THE

HUMAN BODY.

Delivered at the Royal College of Physicians, 1861.

By Lionel S. Beale, M.B., F.R.S.

(*Continued from page* 276, vol. ii.)

Lecture VI.

On the Connective Tissues.—Tendon and other forms of White Fibrous Tissue.—Cartilage.—"Mucous Tissue" of the Umbilical Cord.—Fibrous Tissue formed from Inflammatory Lymph.—Bone.—Dentine.—Stellate Tissue on the Surface of the Cementum.

[As it is not possible to devote sufficient space in this and the next number of the Archives for a full report of the lectures, I propose to give only those portions which contain original observations and descriptions of the specimens exhibited—believing that this course will be most acceptable to the readers of the Archives. I shall thus be enabled to compress the consideration of the principal questions into a comparatively small space, and at the same time to complete the lectures of which five were published in the last number. The lectures will be completed in the next number, and the four remaining plates will be inserted. The lectures and plates have been published in a separate form.]

Tendon is generally subjected to examination after having been dried, or partially dried, and then remoistened with fluid, but it has been found that these processes cannot be carried out without some considerable alteration in the characters of the tissue being produced. The specimens referred to have therefore been prepared without any desication at all. They have been soaked in carmine solution, and afterwards mounted in glycerine, according to the method I have already adverted to.

No. 34 is a longitudinal section of a tendon of a child at birth. Observe the relation of the *germinal matter* to the *formed material.* The lines of oval masses of germinal matter are usually termed "the nucleated fibres of the tendon." These are represented in Plates IV and V, figs. 3 to 10.

In Plate V, fig. 9, longitudinal sections of a tendon from an old man, aged 74, are represented. The principal difference between this and figs. 6 and 8, which are from the kitten and child, is the greater proportion of *formed material* or *intercellular substance,* to the germinal matter. The "parallel nucleated fibres" are very distinct in all the specimens, but they are not nearly so close together in the old as in the young tendon. These points are shown most distinctly in Plate IV, fig. 7 *a b; a* is from the child at birth, *b* from the old man. Now, what is the nature of these so-called nuclei and nucleated fibres? If the tendon be stretched they form narrow lines, and the very elongated nuclei seem to be connected together by very delicate fibres (fig. 9*c*). If the specimen be roughly handled, several nuclei with pieces of fibrous tissue may be detached, and they often assume an angular form with projecting processes (fig. 6). If, on the other hand, they be stretched laterally, they become very wide, and assume an oval form (fig. 9*e, f*).

Longitudinal lines are seen in the oval 'nuclei,' and these are caused by a tendency in the germinal matter to split in the longitudinal direction, or result from peculiar creasings or markings, which, when fully formed, give rise to the fibrous appearance so characteristic of this tissue. If you attempt to make a transverse section, the stellate bodies represented in fig. 8 are obtained. It is impossible to obtain a very thin transverse section of tendon with these nuclei in their natural position. In attempting to do so, you cut off short pieces of tendon with the included nuclei. At the edge of the specimen (fig. 6) are some bands of wavy fibres detached, with the nuclei in them, and in some the immediate continuity of the fibrous structure with the so-called nucleus can be positively traced.

The masses of germinal matter which you have seen in each specimen are regarded by Virchow as areolar or connective tissue corpuscles, "bindegewebs-körperchen," and he states that they are connected together by tubes, so as to produce a stellate arrangement. In a longitudinal section he admits that nothing of the kind is to be seen, but in a transverse section the stellate arrangement is observable. It seems to me that this may be explained thus:—It is not possible to obtain a very thin section in which all the divided parts are *in situ.* In the transverse sections made, some of the prolongations from these

bodies are altered in position, so as to make it appear as if they passed from the corpuscle or cell between and amongst the longitudinal fibres (Plate IV, fig. 8).

These nuclei are the masses of *germinal matter* of tendon, and the fibrous substance is the *formed material* formed from it. The so-called nuclei are certainly connected with the wavy bands of the fibrous tissue, figs. 6, 9, 11. The tissue nearest the nuclei is not yet perfectly formed, and it is so soft that separation usually occurs at this point, and the nuclei or cells escape from the substance of the fibrous tissue in which they appear to have been embedded.

In the nutrition of this texture, therefore, it follows that the nutrient matter passes through, or permeates, the formed material, being drawn to the oval masses of germinal matter as towards centres. Certain of the nutrient elements then become living particles of the germinal matter of tendon, and in due order become converted into the firm, unyielding, fibrous structure or intercellular substance (formed material).

Acetic acid, as is well known, causes the wavy fibrous appearance to disappear, while it renders the so-called nuclei and their lines of connection with each other more distinct. At the same time in fully formed tendon there is a delicate network of yellow elastic tissue, the fibres of which for the most part pass round the bundles of the white fibrous tissue, and are therefore, upon the outer part in contact with the *oldest* part of the tendon, or with the formed material which was first produced.

In fœtal tendon the acid does not produce so striking a change. The wavy bands, the fibrous appearance of which is not so very darkly marked as in the adult, in many cases remain; and thin bands can always be detached and are easily demonstrated to be directly continuous with the so-called nuclei. In many specimens of young tendon it is difficult to demonstrate a single fibre of undoubted yellow elastic tissue. The yellow elastic fibres are always less numerous in young than in adult tendon, while the so-called nuclear fibres are two or three times more numerous in the former than in the latter. The proportion of yellow elastic tissue, therefore, does not seem to be dependent upon the so-called nuclei. The yellow fibres where they exist are not connected with the nuclei, and are separated from them by white fibrous tissue. These elongated parallel nuclei of tendon are not concerned in the formation of yellow elastic fibres, but the germinal matter of which they are composed does become converted into the white fibrous tissue of the tendon. This germinal matter, like that of other structures,

and the fibrous material which it produces, when young and imperfectly formed, are not rendered transparent by acetic acid and other reagents, while the fully formed tissue undergoes the alteration which is so well known. I should state that I have studied the action of reagents on specimens which have been treated with carmine and soaked in glycerine. This latter substance possesses the property of retarding the action of chemical reagents, and by the slow and gradual effect produced it is advantageous.

Fig. 8, Plate IV, shows the appearance of a small piece of a longitudinal section of the tendon of a child at birth. The prolongations from the masses of germinal matter (*cells* or *nuclei*) are well seen, and their communications are tolerably numerous. The specimen has been pressed, and the disposition of the oval nuclei has therefore been altered. The processes are distinct enough in some places, but most of them gradually become lost among the wavy fibres with which all are connected and of which they are but the early stage. Although they somewhat resemble fibres of yellow elastic tissue in their general appearance and in their power of resisting the action of acetic acid, they are not of this nature; their outline is irregular, and when examined with very high powers they have a granular appearance, which is very different to the sharp outline and homogeneous appearance of the yellow elastic tissue. In the dead tissue they may be called tubes, but they are *artificial tubes*, and do not convey nutrient juices during the life of the tissue. The germinal matter and imperfectly formed tissue of which they consist, cannot be regarded as a nutrient material. It is merely an early stage of the fibrous tissue.

Moreover, it must, too, be borne in mind that the appearance so remarkably distinct in fig. 8, which results in part from the pressure to which this specimen has been subjected, is not constant. It is not seen in the specimen of adult tendon already referred to, where fibres of yellow elastic tissue are found, nor in that of the kitten, fig. 6, and in the fascia of the frog there is no more indication of such an arrangement than there is in cartilage. In some specimens of the tendon of the child which have been stretched and pressed, the appearance of stellate cells and communicating tubes is most distinct, but that it depends upon an alteration produced in the nuclei, and upon the displacement and tearing of some of the young tissue connected with them is sufficiently proved by the appearance being produced by pressure, by its absence in parts of the specimen not subjected to pressure, by the great variation in the appearances when the arrangement is produced, and by its

entire absence in certain specimens. The dark lines in fig. 8, continuous with the cells, are not elastic fibres at all, neither are they elastic tissue at an early period of its formation, as will be shown. Elastic tissue when it exists in tendon is not connected with these nuclei.

The altered appearances produced in the same piece of tendon by mere stretching and pressure are shown in Plate V, fig. 9. The fact illustrated in the drawing is most important. The drawing was carefully copied from a specimen which exhibited the usual regular arrangement before pressure was applied, and may perhaps help to explain the cause of the different statements which have been made with reference to the appearance of the so-called cells or nuclei.

How are we to account for the delicate fibres of yellow elastic tissue surrounding the fibres of many specimens of tendon? Their existence is undoubted but they are not in sufficient number to be considered as essential constituents of the tissue, and they are not to be detected in all forms of white fibrous tissue. For the most part they wind round the bundles. By great patience you may occasionally succeed in finding a nucleus connected with these fibres, but when this is so the nucleus is very small, and quite distinct from those I have described as connected with the white fibrous tissue. It is, however, very seldom that I have been able to demonstrate this nucleus in connection with the yellow elastic tissue in tendon, and from the fact that I have seen this appearance result from alterations produced in an undoubted capillary vessel, I am disposed to explain the very few cases in which I have met with it in this manner.

As a rule the fibres encircling the bundles of the white fibrous tissue are certainly not connected with nuclei. The nuclei which are constantly present, exhibit a linear arrangement at every period of the growth of tendon. The yellow elastic tissue on the other hand is not arranged in parallel lines, but the delicate fibres of which it is composed form a lax network.

As to the tubular nature of these fibres of yellow elastic tissue. In yellow fibrous tissue, from many situations I have seen prolongations of germinal matter as in other tissues, but I have completely failed to prove that these yellow elastic fibres generally are tubular, and concerned in the distribution of nutrient matter. Over and over again, I have stained the nuclei amongst the fibres of yellow elastic tissue with carmine, while not a single fibre exhibited the slightest alteration. I cannot think, therefore, that these fibres at any period of

their existence, have any such office as that of distributing nutrient fluid to the tissues in connection with which they are found.

Fig. 5, Plate IV, is a portion of the white fibrous tissue from the fascia covering the muscles of a frog, and this specimen is quite destitute of the yellow elastic tissue. The oval masses of germinal matter, coloured dark red with carmine, are, however, very distinct, and their continuity with the fibrous tissue is equally positive.

Fig. 11, Plate V, represents a vertical section of a piece of thick lymph lying between the liver and diaphragm, from a man who died of scrofulous enlargement or amyloid degeneration of the liver. The mass adhered slightly to the fibrous capsule of the liver, but it could be removed without being torn. In one or two places it adhered very intimately, and had undergone conversion into white fibrous tissue, but the layer generally was not in vascular connection with the adjacent parts. Similar extensive layers of lymph were found over the surface of the intestines. The germinal matter and formed material can be seen most distinctly in the specimen, and the arrangement of the meshes of fibrous tissue is almost as regular as that observed in the proper tissue of the cornea.

We, therefore, conclude that tendon, like fascia and other textures consists of *germinal matter* and *formed material*, and that the formed material bears the same relation to the germinal matter as in other tissues; that the so-called nuclei of the nuclear fibres are the masses of germinal matter which produce the fibrous tissue of the tendon; that the elongated fibres intervening between the cells or nuclei consist of soft material undergoing the process of conversion into the harder fibrous tissue. This soft substance is soon broken down after death and liquefied, and these straight tubes, which are artificially produced, seem to intervene between the oval masses of germinal matter, so that we have a series of straight tubes pursuing a longitudinal course in all parts of the tendon, and exhibiting here and there a dilated portion.

In my last lecture I shall bring forward evidence to show that many tissues which, after having existed in a state of functional activity for a certain time, waste and disappear, leave behind a certain quantity of transparent fibrous tissue, which is not completely removed by absorption. If muscle or nerve waste from any cause, a structure somewhat resembling white fibrous tissue remains behind, and in some cases a similar structure occupies the situation which was filled by a vessel at an earlier period. Let me draw your attention at once to the

cord-like network of fibres in connection with the external coat of a small branch of artery. The specimen is taken from the abdominal cavity of a frog. (Figs. 1 and 2, Plate IV.)

Fig. 1, shows the appearance alluded to under a power of 130; *a* is the outer part of the muscular coat of the artery. A bundle of nerve fibres is seen running in the external coat of the artery, and at *c* some of the fibres are seen to leave the large trunk of the nerve and run in the central part of some of the fibrous cords. In fig. 2 a portion of one of these cords with most distinct nerve fibres is seen magnified 700 diameters, and a transition may be traced from most undoubted nerve fibres to the very narrow branching fibres seen in the upper part of the specimen. These fibres are not altered by acetic acid, but by careful examination it is clearly proved that they may be split up into finer fibres if they are not actually composed of several minute fibres collected together. They somewhat agree in character with the axis cylinder of a nerve fibre. Some of the finest of these cord-like fibres of connective tissue seem to consist of a transparent matrix, in which two or three nerve fibres are embedded. The transparent matrix is the so-called tubular membrane of the nerve fibre. I consider, therefore, that the nuclei and delicate fibres continuous with them, embedded in a more or less fibrous connective tissue, are nerve fibres which were functionally active at an earlier period of life, and that the matrix in which they are embedded corresponds to the so-called tubular membrane. At *e*, three very fine nerve fibres embedded in a matrix are represented, and the fibres represented at *f* are probably altered nerve fibres.

There are in different parts of the frog, especially in connection with the skin and areolar tissue beneath, cord-like fibres very much resembling those just described in their general appearance, but differing from them in the disposition of the nuclei and in the matter which passes between the nuclei, being granular and less fibre-like. Such fibres have the general appearance represented at *b*, fig. 10, and are composed of white fibrous tissue with its nuclei and their prolongations (formed material and germinal matter).

The mode of development of these thick cord-like fibres of connective tissue is represented in fig. 10, from the cutis of the frog. At *a*, numerous oval nuclei are seen undergoing division which occurs transversely and longitudinally. The distance between each gradually becomes increased, and for some time granular matter may be seen intervening between one nucleus and the other. In this case a reticulated arrange-

ment exists, as in certain forms of fibrous tissue and the fully formed tissue represented in fig. 10*b* forms a variety of connective tissue between tendon and fascia where the nuclei form straight lines; and the outer part of the periosteum and areolar tissue generally, where they assume a stellate form.

It is difficult to distinguish the points to which I have adverted in every individual case, but that fibres resembling elastic tissue in their behaviour with acetic acid, are immediately continuous with nerves, and remain in situations where nerves had been abundantly distributed at an earlier period of life will, I think, be fully proved in my last lecture.

Permit me to sum up the prolonged discussion on this question in a few words.

A tissue possessing the characters of white fibrous tissue may be formed like other tissues from germinal matter, or it may result from changes taking place in tissues which originally possessed much higher endowments. In the last case it may serve as a support to the new texture which is developed, and as life advances this tissue, the débris of more important structures, becomes, in certain localities, more abundant. Although it is true that many very different forms of white fibrous tissue exist, it is interesting to observe, in certain cases, the great similarity between the arrangement of the lowest temporary forms of this tissue, of which false membranes are composed, and that of the higher and more permanent forms of the structure, as seen in tendon, fascia, and even the proper tissue of the cornea. (Figs. 3, 4, 5, 6, 7, 11.)

In prep. 38, at one view, you may see some of the youngest portions of the ensiform cartilage of the mouse and its connection with tendon to which muscular fibres are attached. The matrix of the cartilage is in direct continuity with the fibrous tissue of the tendon. Upon a careful examination of this specimen you will observe that the youngest elementary parts are only separated from each other by a very thin line of formed material, and the germinal matter tinted with carmine, seems to shade gradually into the intervening substance. As you pass outwards you see the proportion of formed material between each oval mass, or between the collections of masses, of germinal matter gradually increasing. These very important points are most satisfactorily shown in specimens treated with carmine. As in other tissues, the relative proportion of the germinal matter to the formed material of cartilage, gradually becomes less as we pass from the youngest towards the older parts of the tissue, or, in other words, as the elementary parts advance in age.

Fig. 16, Plate VI, is a thin section through the tendo Achillis and os calcis (in that part which is now cartilagenous) of a kitten soon after birth. In the centre of the specimen is a line marked by the existence of capillary vessels (*a*). This divides the cartilage from the tendon. Observe in this specimen how closely the two structures resemble each other in general appearance. The arrangement of the germinal matter and formed material is the same in both, except that in the tendon there is already an indication of parallel fibres. The proportion of the germinal matter and formed material is about the same in both tissues. In the cartilage the masses of germinal matter divide, and the resulting portions at once become *separate masses.* In the tendon the masses divide, but the resulting portions are *connected together* for some time by a thin line of germinal matter. Between the cartilage and the tendon is a layer which eventually becomes the periosteum. The stellate arrangement of the masses of germinal matter (areolar or connective tissue corpuscles) is very distinct, and their character is retained in the adult tissue. In the drawing this layer is represented. (Fig. 16, *b*, Plate VI).

At an early period of development of all forms of cartilage, masses of germinal matter are seen situated very close to each other, and as the growth advances, the quantity of formed material between them (matrix, intercellular substance) gradually increases. It is formed from the germinal matter. If you examine any of those cartilages in which small parcels of cells exist at intervals through the matrix, you will observe that there exists a greater amount of formed material between the various collections, than between any of the individual masses of each collection. If it be admitted that the matrix is formed from the masses of germinal matter this fact is at once explained. The more recent the division of the mass of germinal matter the thinner will be the intervening layer of formed material between the resulting masses.

In fig. 15 several elementary parts of cartilage from the frog are represented in different stages of growth. The manner in which the matrix is formed is, I think, easily understood after a careful examination of these specimens. At *a*, large oval masses of germinal matter are seen to be separated from each other by a very thin layer of soft formed material (matrix). At *b*, this has increased, but as the germinal matter grows, while the conversion of its outer portion into formed material proceeds, the elementary part becomes larger. The next stage is shown in *c*. In *d, e, f, g, h, growth* has ceased, and the germinal matter gradually undergoes conversion into formed

material until at last only what is termed the nucleus remains, and this in many instances dies and a small oval collection of granules, which are not tinged red with carmine, *h*, is all that marks the position of the germinal matter of the cartilage cells by which the matrix, or formed material, has been produced. After this has occurred the matrix may become harder and undergo other changes, but no more can be produced. The *formation* of the matrix has ceased. The matrix, close to the germinal matter which is recently formed is of course soft, and when it is broken away the mass of germinal matter within escapes entire. In all tissues the bond of union between the germinal matter and formed material is very slight; a fact which receives a simple explanation upon the view of growth brought forward. The matrix gradually undergoes condensation and probably contracts somewhat after it has been formed.

In fig. 17 the formation of fat, a change which is not unfrequently observed in cartilage, is traced. A small globule of fatty matter, is first seen in the germinal matter of an elementary part external to the nucleus (fig. 17 *d*), as this increases the nucleus is pushed over to one side, and gradually becomes compressed between the fatty matter and the recently formed matrix of the cartilage. The changes occurring in cartilage during the formation of fatty matter resemble those which take place in the development of ordinary adipose tissue.

The formation of cartilage is generally described in a very different manner. It has been said that the membranous capsule of the cartilage cell *sends in septa* when the cells it contains, undergo division "which serve as new envelopes for the young cells, yet in such a way, that even the gigantic groups of cells, which proceed from each of the original cells, are still enclosed in the greatly enlarged parent capsules." (Virchow).

Against this theory I have endeavoured to show that the matrix or intercellular substance with the membranous capsules of the cartilage cells corresponds with the cell wall of a spore of mildew, Plate XII, Vol. II. This outer capsule of the mildew, as I have tried to prove, does not possess the power of growth. It is the internal germinal matter which is alone concerned in the growth of the plant. So in cartilage, the matrix was once in the state of germinal matter. The septa do not *extend themselves in, or grow in*, but the material of which they are composed results from an alteration taking place in the oldest particles of the germinal matter.

MUCOUS TISSUE OF THE UMBILICAL CORD.

Let me now ask your attention to the anatomy of a peculiar connective tissue which has been particularly studied by Virchow, and on the structure of which he lays the greatest stress, for he states that in a good preparation, "a symmetrical network of cells is brought into view, which splits up the mass into such regular divisions that by means of the anastomoses which subsist between these cells throughout the whole of the umbilical cord, a uniform distribution of the nutritive juices throughout the whole of its substance is in this instance also rendered possible."

Fig. 12, Plate V, is a specimen of the "mucous tissue" from the umbilical cord, under a power of 130 diameters. The texture appears to be composed of delicate fibres with oval nuclei, which are for the most part arranged to form the boundaries of small circular spaces, in which are seen more delicate fibres arranged without regularity. The interspaces between the fibres are occupied with a transparent fluid.

In Fig. 13, some of the fibres and their nuclei are seen under a power of 700 diameters.

The preparations of this tissue which I have made exhibit a great number of the so-called fibre cells. In very many instances the continuity of the germinal matter with the *outer fibrous portion* of each elementary part is most distinct. I have not succeeded in demonstrating the appearance figured and described by Virchow. What appears to be a space or cavity in the centre of the elementary parts is really occupied with germinal matter, and the apparent tubes contain prolongations of this with the recently formed and soft fibrous tissue, which very readily breaks down. The arrangement of the fibrous tissue is shown in the drawing. It will be noticed that there is not the slightest resemblance between my drawing and Virchow's figures. (See pp. 98 and 100 of Dr. Chance's Translation.) It is impossible to represent in a wood engraving the extreme delicacy of the real fibres, but with this exception I think my drawing is a fair copy of the specimen.

Fig. 14 represents some of the muscular fibre cells which form a very thick layer around the arteries of the cord. The relation and mode of formation of the formed material in both structures are the same, but its properties are very different.

The so-called "mucous tissue" of the cord seems to be composed of a soft form of fibrous tissue which is produced in the

same manner as the formed material of other tissues. I have not been able to make out in it an arrangement of channels as Virchow has described. I cannot, therefore, agree with his statements with reference to the existence of a special canalicular system for the circulation of the nutrient juices in this tissue.

Bone.

Fig. 18, Plate VII, shows how the perfect and more permanent bone is produced by changes at the periosteal surface. The temporary imperfect bone is entirely replaced by the structure thus formed. Although in its general appearance my drawing is seen to resemble others which have been given, it will be found to differ from them in some most essential particulars. In the figures referred to, the cells are themselves seen to become stellate, while in my drawing the stellate appearance is shown to depend not upon any alteration in the form or position of the cells or nuclei, but merely upon the manner in which the calcareous matter is deposited in the formed material.

No stellate corpuscle has been produced, but the stellate appearance seems to result from the circumstance that the calcareous matter has been deposited in the matrix in such a manner as to leave intervals of a form more or less stellate. The reason of this will presently appear. The calcareous matter is at first deposited so as to form a network with nearly equal meshes. Each space contains an oval mass of living germinal matter and is the earliest condition of a lacuna. (Fig. 18, *d.*)

The elementary parts concerned in the formation of lacunæ in the above specimen are represented in different stages of growth in figs. 19, 20, 21, under a power of 1700 diameters.

Fig. 26 shows the manner in which the earthy matter is deposited in the matrix of cartilage. It is copied from a section of the temporal bone of a frog. Globules of earthy matter may be seen to form imperfect rings around the cartilage cells. The calcareous matter is always deposited in the matrix (formed material), at a point midway between adjacent "cells" that is in the oldest portion of the formed material of the cartilage. The deposition gradually proceeds from without inwards. The outer part of the germinal matter of the cell gradually undergoes conversion into matrix, which in its turn becomes impregnated with calcareous matter until only a small space remains in which the nucleus still exists.

Figs. 25 to 30 show these stages, and in many specimens, especially from the frog, rounded globules of calcareous matter which coalesce and undergo great change in form, can be demonstrated without difficulty in lacunæ in an advanced state of formation (fig. 29). Mr. Rainey has watched this process and seems to consider that molecular alterations in the earthy particles are the essential changes to which the formation of bone is due.

I have examined the process of ossification as it occurs in various animals with the aid of carmine, and have always been able to demonstrate masses of germinal matter in a position corresponding to the lacunal space. I believe these masses of germinal matter to be as necessary to the production of bone as they are to the formation of every other tissue, and feel certain they are constantly present, and that through their agency alone, osseous, as well as all other tissues, is formed. They are not directly concerned in the deposition of the calcareous matter, but the matrix in which this is deposited cannot be formed without them, and it is probable that by their instrumentality alone the regular circulation of fluids holding the calcareous matter in solution is maintained, and thus the extreme regularity with which the growth of the tissue occurs is ensured.

For some time after the first deposition of the calcareous matter in the formed material, very thin fragments of the bone torn away exhibit the appearance of fibres (a fact pointed out many years ago by Dr. Sharpey), in the substance of which globules have been deposited (fig. 31), but slowly the calcareous matter becomes more homogeneous, in consequence, probably, of changes occurring in its substance, and its more perfect incorporation with the organic matrix, and ultimately the hard mass appears even in texture, uniformly transparent, and penetrated everywhere by minute tubes.

It seems to me that these tubes are the altered spaces which are left between the calcareous globules originally deposited. They were at first triangular in outline, but gradually they have become altered by the filling up of the angles, until at last they become pores, the section of which is nearly circular.

From appearances I have seen in some preparations of the bones of the frog's skull (frontal, parietal), I feel sure that in this case the bone results from changes in the original cartilage. The nucleus of the cartilage cell remaining as the nucleus in the lacuna. The calcareous matter deposited in the matrix around a cartilage cell undergoes changes, probably slowly becomes incorporated with the organic matter, and gradually ceases to exhibit the appearance of being composed of separate

masses, and becomes more homogeneous. The spaces become canaliculi, and the mass at last assumes the structure of perfect bone.

For some time separate calcareous particles are seen within the outline of the lacunæ, which gradually diminishes in size as calcareous matter is deposited in the matrix from without inwards. Fig. 29 represents about one-third of the inner part of a recently-formed lacuna of the frog, magnified 1,700 diameters. A part of the nucleus is seen in the lower part of the drawing.

In the development of the long bones of mammalia, on the other hand, it is equally certain that the spongy, imperfectly formed bone at first developed is gradually removed, and gives place to new bony tissue of a more perfect structure not formed from cartilage, while, as is well known, there are examples of the formation of bone without the existence of cartilage at any period, in the case of certain bones of the cranium.

Kölliker considers that the capsule of the cartilage cell and the matrix, become impregnated with calcareous matter, while the granular cell corresponding to the primordial utricle of the vegetable cell and with the endoplast of Mr. Huxley, remains within unaltered. He thinks that the canaliculi extend through the matrix by resorption.

Virchow regards bone as consisting of cells and an intercellular substance, and he considers the canaliculi to be processes which grow from the cells.

In the following MS. note, copied from page 417 of Dr. Chance's translation, he expresses himself very clearly as to the manner in which processes are formed from cells. "The cartilage cells (and the same holds good of the marrow cells), during ossification throw out processes (become jagged) in the same way that connective tissue corpuscles, which are also originally round, do, both physiologically and pathologically. These processes which in the case of the cartilage cells are generally formed after, but in that of the marrow cells frequently before, calcification has taken place, bore their way into the intercellular substance, like *the villi of the chorion do into the mucous membrane and into the vessel of the uterus*, or like the Pacchionian granulations (glands) of the pia mater of the brain into (and occasionally *through*) the calvarium." Again, "The cells which thus result from the proliferation of the periosteal corpuscles are converted into bone corpuscles exactly in the way I described when speaking of the marrow. In the neighbourhood of the surface of the bone the intercellular substance grows dense and becomes almost cartilaginous, the cells *throw out*

processes, become stellate, and at last the calcification of the intercellular substance ensues."

There are few points in minute anatomy upon which such different views have been advanced as the one under consideration, and you cannot fail to notice that observers differ not only in the explanations and opinions they have put forward, but that there are irreconcilable differences in their statements of the facts.

Although many observers have described and somewhat faintly expressed in their drawings the growth of the processes referred to, all agree that they are most difficult to see in healthy growing bone. My own observations compel me to oppose the statements generally made with regard to these processes. As far as I have been able to see, neither the cartilage cell, nor the medullary cell, nor the periosteal cell, nor indeed any cell in the organism becomes stellate by the "shooting-out process." That cartilage and the other "cells" may become angular is perfectly true, and that a few little projections may be seen from different parts of their surface is also true, but these projections and angles have nothing to do with the formation of canaliculi. The appearance is exceptional instead of being constant, and a lacuna with numerous canaliculi may be produced without the existence of an angular cell at all. The mass of germinal matter is oval from the period it first existed as a separate object to the time its nucleus is seen in the lacuna. Into each lacuna forty or fifty or more canaliculi open, and these communicate with those of adjacent lacunæ. Surely, if these were formed in the manner described we ought to be able to demonstrate something like this during the formation of the lacunæ, but nothing of the sort has been seen, and the warmest advocates of the theory have only been able to observe a very faint indication of the arrangement which they believe actually exists. Their drawings only show these processes projecting a very short distance from the cells, and no one, I believe, ever pretends to have seen processes from two neighbouring cells in process of communicating with each other, as exists constantly in the perfect canaliculi of bone. It is not only very difficult to conceive such channels formed by an out-growth, but it is inconsistent with what is generally observed, to suppose that channels are scooped out in a tissue which has just been formed. The tissue *during its formation* requires channels for the transmission of nutrient matter just as much as after its formation is complete.

If the canaliculi were formed as described it is quite impossible that every observer should have failed to see the prolonga-

tions of the cell undergoing development and coalescing with those of neighbouring cells. The extremities of these tubes which were gradually extending through the matrix would be rounded, and would contain germinal matter which would absorb the solid matrix, and thus the tube would extend through its substance. No such appearance has ever been seen. The canaliculi are no more processes of the cell which bore their way through the hard material than the tubes which are found in the masses of secondary deposits in the hard walls of certain vegetable cells are processes of the germinal matter in the centre of the cell.

Again, it is very difficult to understand why tubes growing centrifugally from adjacent cells should not grow outward, at least at first, in direct lines, and reach each other by the shortest cuts, while, according to my view, as the deposition of the calcareous matter commences always at the point where two elementary parts coalesce, where the oldest part of the formed material is situated, it is easy to see how the canaliculi, or spaces left, must be continuous with each other, and their tortuous course also receives explanation from the fact, that the particles first deposited become globules before the process of ossification is far advanced.

It may be said, if you please, that the growing matter extending from a spore of mildew bores its way into the soft material, at the expense of which it grows, but here this soft material is clearly appropriated by the mildew, and becomes converted into the germinal matter of the plant, but this process is totally different from that by which canaliculi are produced.

Myeloid cells (Plate VII, fig. 24) are a good specimen of the so-called myeloid cells from one of the cancelli of the bone of the great toe. Two or three of the masses are elongated and much bent. These I believe might afterwards become ossified and form the spiculæ of bone which form the imperfect septa between the cancelli. Around these are many small granular cells, and it is interesting to notice the fact, that while the first structures are of a dark-red colour the latter are scarcely tinged with the carmine, although both have been exposed to its influence in the same way. The first is growing actively, the last is comparatively inactive, and there can be no doubt that it is being gradually removed as the former structure advances. What remains will become the medulla. The so-called myeloid cells are not peculiar to the cancelli and the medullary membrane of bones, but they are also formed in the periosteum. Under ordinary circumstances many of them gradually become

converted into bone, but in disease they increase in number rapidly, producing a soft, spongy structure which only undergoes very imperfect ossification or receives no calcareous deposit at all. In these so-called myeloid cells I have not been able to distinguish a cell wall. Each mass is composed of a number of small oval elementary parts, each of which consists of an oval mass of germinal matter which is faintly coloured, while the nucleus is coloured dark-red with carmine. The germinal matter gradually undergoes conversion into a soft formed material externally, which increases in thickness. Afterwards the nucleus diminishes in size. In some cases the formed material exhibits a somewhat fibrous appearance.

Dentine.

There are few anatomical questions which have given rise to more controversy, than the structure and mode of formation of the dentine, and the very last writer on the subject, M. Lent, describes the dentinal canals as consisting of direct processes of the whole dentinal cells. "The matrix of the dentine is not formed of the dentine cells, but is a secretion of these cells and of the tooth pulp, in other words, an intercellular substance.*" Now, Mr. Tomes has shown that the dentinal tubes are occupied with a soft solid structure which may be seen projecting in the form of solid processes from the broken ends of the dentinal tubes. The truth of these observations has, however, been doubted by several observers. I have been able to verify Mr. Tomes' statements as to the dentinal tubes being occupied with this soft structure, and now send round a preparation in which this material has been coloured red with carmine, and is most clearly demonstrated (No. 49). The dentinal "tubes" of a *living tooth* are never empty; indeed they are not tubes, nor are they canals for the transmission of nutrient substances dissolved in fluid, but they contain a soft solid substance, the central portion of which is in a state of active vitality.

Imagine for a moment one of the soft nuclear fibres of tendon surrounded with a matrix impregnated with calcareous matter and you will form, I believe, a good idea of the structure of the "dentinal tube" and its contents.

The wall of the tube with the matter between the tubes correspond to the "wall" of an ordinary cell, or to this and the intercellular substance (my *formed material*), and the contents of the tube to the granular cell contents with the nuclei (my

* Kölliker's Manual of Microscopic Anatomy, page 307.

germinal matter). If you look at the tissue of the pulp just beneath the surface of the dentine you find a number of oval masses of germinal matter coloured intensely red by carmine. These are nearly equidistant and separated from each other by a certain quantity of material which is only very faintly coloured, and in cases when the solution was not very strong it remained colourless. This colourless matrix is continuous with the *intertubular dentinal tissue,* while the intensely red germinal matter, or rather a prolongation from it, extends into the dentinal tubes. The germinal matter with a thin layer of soft and imperfect formed material is easily detached from the formed material by which it is surrounded, and its continuity with the dentinal tubes may often be torn away, (prep. 50). The whole then appears as an oval mass (cell) with a prolongation as it were into the dentinal tube. (Fig. 32, *a*, Plate VIII).

The general description given of the manner in which these dentinal tubes *open* upon the walls of the pulp cavity is certainly true, but it is true only of the dry tooth. In the living tooth a prolongation from one of the "cells" on the surface of the pulp is prolonged into each tube. The tubes cannot, therefore, serve as mere conduits for nutrient fluids which transude through the walls of the vessels, and are supposed to pass along the tubes to the outer part of the tooth. Moreover, in some cases certain of the so-called dentinal tubes are completely solid, the tube being obliterated (fig. 36). These points receive a ready explanation from a careful consideration of the facts I have brought forward.

The specimens which have been sent round prove, I think, that the formation of the dentine and the so-called tubes, is effected in a much more simple manner than is usually believed. The elongated masses of germinal matter first of all produce *formed material,* which gradually increases as in other cases, upon the outer surface of the germinal matter. The formed material of the adjacent elementary parts is continuous, and calcareous matter is first deposited in the oldest part of this formed material. The calcareous matter appears in the form of small globules, which gradually increase in size, and often several coalesce. Thus the formed material, or matrix, of the dentine becomes calcified. (Fig. 32, *a*).

Not unfrequently, however, several of the calcareous globules increase in such a way as to inclose a portion of uncalcified matrix. This being, as it were, imprisoned by hard impermeable structure retains its soft primitive state. If the tooth be dried the soft matrix in these spaces shrinks and air rushes in. Thus the appearance known as "globular dentine"

is produced, and the reason why uncalcified tubes are seen traversing these spaces becomes manifest.

After the matrix of the dentine is calcified the germinal matter still slowly undergoes conversion into formed material, which in its turn becomes impregnated with calcareous matter. The germinal matter diminishes in thickness. The formed material is produced more slowly after the general basis has been laid down, and hence the dentine immediately surrounding the tube seems to be distinct from that lying in the intervals between the tubes. The germinal matter gradually shrinks from the outer part of the dentine (the oldest portion) towards the pulp-cavity, where these changes still go on. In the dry tooth the same fact may be expressed by saying that the narrowest part of the dental tubes is at the circumference of the dentine, and this part was the first formed; the widest part is that which is in contact with the pulp, and this is composed of dentine most recently developed. Internal to this is a narrow layer, the formed material of which is not yet calcified.

Figs. 33, 34, 35, 36, 37, are copied from specimens taken from different parts of the dentine. They show the varying diameter of the tubes, and are confirmatory of the observations just made.

The appearances I have described can only be demonstrated in perfectly fresh teeth, which have been placed in carmine solution very soon after extraction.

The principal changes in such a tissue as dentine seem to consist of the conversion of germinal matter into formed material, and the impregnation of this formed material with calcareous matter, rapidly at first, but more slowly as the quantity of calcareous matter increases. In the adult, the remains of the germinal matter slowly undergo conversion into formed material, and this slowly becomes impregnated with calcareous cells. In old age, although the pulp is very much reduced, this conversion is not complete, and a certain amount of germinal matter still remains in the tubes and in the pulp cavity from which dentine might have been produced.

Tissue with Stellate Cells.

Stellate tissue on surface of crusta petrosa.—Upon the surface of the fang of the tooth in contact with the crusta petrosa is a tissue of a very interesting structure, which takes part in the formation of the cementum. It is composed entirely of what may be described as branching cells (elementary parts), the processes of which anastomose freely with each other. It is from

this tissue that the crusta petrosa is formed; but I allude to it here because it is a most perfect example of a tissue consisting entirely of cells, the cavities of which *communicate with each other by tubes.* The stellate cells are here as distinct as they are in the pith of the rush. But do these cells and tubes merely constitute an elaborate system of channels for the distribution of nutrient material to the tissue which intervenes between them? This tissue, it may be remarked, grows very slowly; it is a very low simple form of tissue, and probably requires but very little nutrient matter. If the above view is adopted it must be admitted that the means for nourishing the structure are far more elaborate than would be expected, supposing the conclusion is accepted that there ought to be a constant relation between the activity of change in a tissue and the mechanism for bringing new matter to the elementary parts and carrying off the effete material from them.

Neither does it appear that all these bodies become lacunæ of the cementum. The stellate cells just described for the most part have not more than from ten to twelve processes or tubes projecting from them, while many of the lacunæ of the cementum have as many as thirty or forty, hence these tubes are certainly not an early stage of the canaliculi, and the cells cannot become lacunæ simply by the deposition of calcareous matter in the intervening matrix or intercellular substance.

This stellate tissue on the surface of the fang nevertheless undergoes calcification. The process of calcification may be seen to take place in specimen 52. The processes of the stellate masses become narrower and narrower until, the germinal matter, which they contained, having undergone conversion into formed material, they cease to be coloured by carmine. (Fig. 43, Plate IX). They now look like roundish, highly refracting cords, which are colourless, and connect the several stellate masses of dark-red germinal matter with each other. Here and there in the intervals between these processes small globules of calcareous matter have been deposited, and these increase and completely surround the cord-like processes. Many of the processes gradually assume the character of the surrounding matrix, disappear as distinct cords, and like the rest of the tissue become impregnated with calcareous matter.

Many of the stellate masses of germinal matter (cells) shrink and disappear in consequence of the same changes having occurred. Others remain with their processes, and their nuclei possibly remain as the nuclei of the lacunæ which are irregularly distributed through the cementum; but I cannot express

myself positively on this point. It is certain that all the cells do not become lacunæ, for in this tissue there are half-a-dozen stellate cells to one lacuna in the cementum, and many of the canaliculi are five times as long as these tubes. Are these processes tubes? This question would doubtless be answered in affirmative by every one who examined the tissue long after death, but during life they contain a solid, or semi-solid, substance corresponding to that which occupies the so-called dentinal tubes. They contain portions of the germinal matter which is undergoing conversion into formed material, and the situations in which these tubes existed are the last portions of the formed material to undergo calcification.

This is precisely the same change which takes place in the calcification of the dentine, the only difference being in the forms which the masses of germinal matter assume in the first instance. It need hardly be remarked, that cementum, as it ordinarily exists upon the fangs of the human teeth, differs from true bone in its greater degree of hardness, in the small number and irregular arrangement of its lacunæ, and in the absence of the arrangement for its absorption and reproduction. It is a more permanent but less perfect tissue than bone.

Stellate fibre cells from the aorta, Preparation 43, is a very thin section of the circular coat of the aorta, coloured by soaking in carmine, showing large stellate muscular fibre cells. It will be interesting to compare this with the tissue upon the fang of the tooth. The radiating processes seen in this specimen are clearly not tubular; the large stellate elementary parts were very readily separated from each other. I hope you will particularly remark that in this specimen the central part of each is very darkly coloured by carmine; external to this the structure is coloured, but the colour becomes fainter in the most external portions, and the outermost part of each fibre and its prolongations, are perfectly colourless. The fibrous character of the tissue is sufficiently manifest. As in many other cases, the germinal matter is here seen in the centre of the mass, and is gradually giving rise to the production of formed material, the oldest and that which is perfectly formed being at the greatest distance from the central mass, while that which was but recently germinal matter, and is now in a transition state, is continuous with it. The latter is slightly coloured with carmine while the perfectly developed formed material is not coloured at all. (Fig. 44).

Let me, in conclusion, offer a few general observations upon the formation of bone, dentine, and the beautiful stellate tissues, represented in figs. 43 and 44.

The early formation of bone is not the least like the early formation of a tissue with stellate cells. In the former the so-called cells (masses of germinal matter with formed material externally) are round or oval at every period of their development, and may be separated from each other without difficulty. In the stellate tissue the masses of germinal matter are connected together for a considerable period of their existence; at first the points of communication are wide, but they gradually become narrower and narrower as the distances increase, and at last they are reduced to narrow processes which at length undergo conversion into formed material. The germinal matter of the different masses may communicate through these processes up to a certain period, but gradually they become more solid, and then the masses are distinct, but still connected to each other by narrow cord-like processes.

The nutrient material passes to the germinal matter of each mass, and to that prolonged to each *through* the formed material which is deposited in the intervals. In some stellate tissues fluid only exists in this situation, which is afterwards absorbed, leaving spaces between the walls of the tubes into which air passes.

The dentinal tubes, and the tubes of the stellate tissues, therefore, do not correspond to the canaliculi of bone. Their counterpart is seen in many vegetable tissues (Vol. II, Plate XII, figs. 1*k*, 2), at the point where the separate masses of germinal matter are connected together; while the channels corresponding to the canaliculi are the pores through the secondary deposits in vegetable cells. (Vol. II, Plate XV, figs. 2, 3).

The stellate cells are stellate from the very beginning. The bone cell is never stellate at any period of its existence. The tubes in the first case contain germinal matter. The tubes in bone are merely spaces left between the particles of calcareous matter which are deposited in the matrix, and for this reason do not exist in the formed material of bone or cartilage prior to the deposition of calcareous matter. They are present when calcareous matter is deposited in cartilage. The dentinal tubes correspond to the processes from, and the cavities of, the stellate cells, but they differ entirely from the canaliculi of bone. The so-called tubes in the stellate tissue and in dentine are no more tubes than the space filled with germinal matter in an elementary part—say of the cuticle—is a cavity. Spaces remain if the germinal matter is removed; but during life these so-called tubes and spaces are occupied with the most important part of the whole structure,—the living, active-growing germinal

matter. The canaliculi of bone, therefore, do not correspond to the above tubes or spaces; they do not contain at any period of their formation germinal matter. They are mere channels left during the deposition of calcareous particles in the formed material.

These channels in bone are, no doubt, subservient in a very important degree to the rapid changes which occur in this hard tissue. The bone tissue could not be so rapidly formed or so quickly removed if it were not freely permeated by canals. In dentine the formed material becomes much more slowly impregnated with calcareous matter and incorporated with the organic matter, so that a very hard, even, and very permanent structure results in which pores exist only in certain parts, especially in the granular layer of the dentine.

In all cases the formed material is impregnated with calcareous matter from without inwards. The necessity for the existence of bone at a very early period of development, the gradual alteration in the size of the bones during the growth of the body, and the changes in their form seem to be incompatible with a mode of development like that by which dentine is produced.

While Virchow has been led by his researches to the conclusion that nutrient tubes exist in connexion with cells in soft tissues, the results of the observations I have recorded in this lecture, have compelled me to conclude that such tubes do not exist in soft tissues as tubes for the transmission of nutrient material, and that even the so-called dentinal tubes are not nutrient canals; while it appears that the canaliculi of bone which are of this nature do not correspond to the dentinal tubes, or to the communicating system of channels in a tissue composed of stellate branching cells, but are mere spaces left during the rapid formation of a tissue impermeable to fluids.

Lecture VII.

Connective Tissue, continued.—Intercellular Substance (formed Material).—Cells or Nuclei (Germinal matter).—Areolar or Connective Tissue Corpuscles and the system of communicating nutrient channels.—Areolar Tissue.—Nerves in Skin of Mouse.—Mucous Membrane of Fauces.—Pericardium, its nerves and ganglia.—Voluntary Muscle.—General remarks on Areolar Tissue.—Conclusion.

Although the connective tissues are generally described as composed of *cells* and *intercellular substance,* I brought forward a number of facts which seem strongly opposed to the view generally entertained, and the preparations which were passed round have, I trust, at least, convinced you that the explanation I have advanced is not incompatible with the facts which were observed. I hold that the so-called intercellular substance exactly corresponds to the cell wall, and like it was formed from germinal matter.

I have tried to show that at an early period of the development of all these tissues there is no proper intercellular substance; and by examining the same tissue at various stages of its growth one cannot but come to the conclusion that the structure, which in the fully developed tissue seems to lie between the cells, formed at an earlier period part of the substance of the cells; that an elementary part of adult cartilage or fibrous tissue, for instance, consists of germinal matter, and formed material upon which the peculiar characters of the tissue entirely depend; and that the proportion of formed material gradually increases as the age of each elementary part

advances, so that the masses of germinal matter become separated from each other by greater distances. As a general rule the formed material of the constituent elementary parts of connective tissues is continuous, and it is not possible to isolate each elementary part as in epithelium and such structures; but in certain cases even this can be effected, and the analogy becomes so distinct that it seems impossible to separate the class of connective tissues from epithelial structures on the ground of any mere differences of structure or mode of growth.

I propose now to consider the bearing of the anatomical points I endeavoured to prove in my last lecture upon the question of connective tissue generally. I shall first allude to the intercellular substance, and afterwards consider the nature of the "cells" or their representatives in this series of tissues.

Intercellular Substance (Formed Material).

Many observers in the present day seem to consider that the intercellular substance is of far higher importance than the cells or nuclei embedded in it. This *matrix* or *intercellular substance* has been supposed, too, to play a most important part in morbid changes. It is considered that the intercellular substance possesses active powers. It may be at first composed of a soft and perfectly clear and homogeneous substance, but it subsequently undergoes important changes in its properties. By some observers it is supposed to become *differentiated* into various substances by virtue of its own inherent powers, while others attribute the changes which occur to the action of the cells. It is asserted that in all connective tissues, cells and an intercellular substance can be satisfactorily demonstrated. In white fibrous tissue the yellow elastic tissue is said to be developed from, and is the representative of, the cellular element, while the white fibrillated tissue is regarded as the intercellular substance which by many is supposed to be formed independently of cells. This part of the question has already been considered in page 74.

It appears, then, that some observers consider that the intercellular substance is simply deposited from the blood, and perhaps somewhat modified by the action of the cells between which it is formed, while by other authorities the intercellular substance itself is believed to possess inherent powers of growth, assimilation, and conversion.

If the intercellular substance of white fibrous tissue and cartilage is merely deposited from the blood by a process akin to crystallization, some substances from which gelatine or

chondrin could be obtained should exist in that fluid. But no such substance has ever been detected.

If, on the other hand, this intercellular substance possesses formative power, and by its own inherent powers can convert certain nutrient materials into matter possessing the same properties as itself, what end is served by the germinal matter which is so constant? And why are these masses so much more numerous in young than in fully developed cartilage? The object fulfilled by the growth of such textures as fibrous tissue and cartilage is the formation of the so-called intercellular substance upon which all the properties of the tissue depend. It is in this that the peculiar properties of firmness, strength, or elasticity reside; for the cells (masses of germinal matter) certainly do not possess any such characters. If, then, this substance can increase itself, wherefore are the cells present at all? The universality of the presence of germinal matter is meaningless, and its abundance in all rapidly-growing tissues, its gradual diminution as the formed material increases, and the deterioration in the properties of the tissue constantly associated with its abnormal increase or with its death, are facts which do not receive explanation.

If both cells and intercellular substance require to be nourished, what regulates the exact supply so that neither increases upon the domains of the other? And how is it that the selected powers of each are exactly balanced?

The investing membrane of a spore or a portion of the stem of mildew, or other simple plant, corresponds to the so-called intercellular matrix of tendon, cartilage, &c. If the latter grows by selecting substances from the nutrient fluid which bathes it, the former must be produced by selecting substances from the fluid which surrounds it. But I have shown that the inner germinal matter may diminish as the cell-wall increases in thickness, and that while there are many examples of germinal matter which is not surrounded with a distinct cell-wall or intercellular substance, there is not an instance of the latter existing in a growing state without the former. When the mildew grows, so far from the outer material or cell-wall increasing in thickness, it becomes thinner (Vol. II, Plate XII, fig. 1*d*, *l*, *m*, *n*). It is the germinal matter within which increases. The germinal matter alone grows, and the more rapidly it increases the thinner is the external membrane (formed material) found to be. A small portion of the germinal matter of the mildew placed under favourable conditions will grow and will produce the formed material or cell-wall, but the cell-wall from which the germinal matter has been removed will

not grow under any circumstances whatever. The envelope or cell-wall exhibits the same characters after the death of the germinal matter as it possessed during its life, but the germinal matter undergoes very rapid changes after death: it soon becomes liquefied, passes into decomposition, and various chemical compounds are formed which did not exist during its life, which, in fact, are incompatible with its life and with the changes which occur while it is alive.

Cells or Nuclei (Germinal Matter).

The germinal matter of connective tissues differs remarkably in its arrangement, as has been stated. Reference should be made to Plates IV, V, VI, and VII, in which the germinal matter is shown embedded in the formed material of tendon, cartilage, bone, and dentine. Although in many cases in the adult tissue the proportion of formed material (intercellular substance) is very great, this is not the case in the young tissue. At an early period of development of all these textures, germinal matter is present in considerable proportion. I have endeavoured to show how the formed material is produced, and have brought forward numerous observations in support of the view that the intercellular substance results from changes in the germinal matter, and that these textures, like all others, originate from this substance.

Those who consider the so-called nucleus as the least important and least constant part of the tissue will perhaps answer the above remarks by the assertion that nuclei are not to be detected in all tissues, and by calling attention to observations in which these nuclei are stated to be vacuoles in a homogeneous structure. I have already stated that they are much more numerous in many tissues than is generally supposed, and are to be demonstrated only by the action of carmine and certain other colouring matters. With regard to the so-called *vacuoles* in young tissues generally, let me remark that the clear material occupying these spaces is the substance I have termed germinal matter, which becomes coloured red by carmine.

In young vegetable tissues the term vacuole is applied to spaces containing a transparent material which occupies the same position as that in which the primordial utricle is afterwards found. This transparent material and the primordial utricle are both coloured by carmine, and both consist of germinal matter. The manner in which secondary deposits occur in the substance of this germinal matter has been referred to in page 263, Vol. II.

As I have shown that the material (germinal matter) coloured red by carmine in cartilage and tendon exactly corresponds to that in epithelium, and that neither cartilage, epithelium, nor any other structure exists in a growing state without it, surely I am justified in the inference that it is *essential* to these tissues. If cartilage could be formed without germinal matter the cell-wall could be produced independently of it. There is no more reason for believing that cartilage or fibrous tissue can be produced from a nutrient fluid without the agency of active living matter than that this living matter can be precipitated from a fluid composed of a solution of inanimate matter.

The contents of cells are easily removed from the investing membrane, or from the walls of the cavity in which they are contained, because the structure which lies between the germinal matter and the perfectly-developed formed material, although continuous in the natural state of the parts with both, is exceedingly soft. It is no longer composed of particles like the germinal matter which are held together as a viscid coherent mass, nor is it yet sufficiently firm to possess the powers of resistance resident in the fully-developed formed material. The substance in this situation is in a transition state, and separation very easily takes place at this point. After death changes commence very soon in this imperfect formed material.

Areolar or Connective Tissue Corpuscles, and their System of Communicating Nutrient Channels.

The term *areolar* or *connective tissue corpuscle*, has been applied to the corresponding structures in several different tissues. In certain textures where I can prove that nerves and capillaries are abundant, a vast number of these connective tissue corpuscles are said to exist. The nature of the so-called areolar tissue corpuscles in the skin and other tissues will be discussed shortly.

Supposing the relation I have described as existing between the germinal matter and formed material of tissues to be true, and the arguments I have advanced sound, it follows that if this term is applied to the elementary parts of bone, cartilage, and tendon, it must also be applied to those of muscle, nerve, the epithelium of the skin, glands, &c., for the germinal matter of cartilage makes cartilage, that of tendon tendon, and those of muscle, nerve, epithelium, &c., produce the formed material which exhibits the peculiar endowments characteristic of these tissues.

With regard to the existence of spaces and tubes, it has been observed that, under certain circumstances, spaces are undoubtedly to be demonstrated in the substance of various tissues, and connecting these there are tubes. They do not exist, however, as spaces and tubes for the conveyance of nutrient fluids in the living tissue. Both are the result either of a change occurring in the course of nature, or are artificially produced by the alteration of their contents by chemical reagents, the action of water, &c. In the first case the tissue is dying or dead, but the last is the explanation when tubes and spaces are said to have been demonstrated by the passage of air or coloured fluid in tissue, which was recently in an active growing state; except in the case of bone and analogous structures, where tubes are present. In short, these so-called spaces and tubes in soft tissues actually contain the active living part of the tissue. It is here that the inanimate nourishment commences its life, and passes through various changes until its place is occupied by new matter, and it has become firm and hard, and perhaps comparatively permanent, as tissue. The tubes and spaces really contain living spherical particles in all stages of being, from the recently animated matter to the particles becoming tissue. The soft living material is, of course, easily destroyed, soon decays after death and leaves spaces and tubes, but during life these are occupied with the only matter of the tissue which can produce new matter, the material on which the growth, the nutrition, in short, the life of the whole depends.

In pathological alterations the germinal matter of cuticle or of cartilage will undergo multiplication in precisely the same manner as the germinal matter of a tissue, the several masses of which communicate with each other by tubes.

It has been shown that in some tissues, as cartilage, the masses of germinal matter are entirely separated from each other by formed material, while in others as tendon they are continuous. Gradually, however, these channels of communication in many tissues become completely closed up, although their position continues to be marked by a line exhibiting a different amount of refractive power to the rest of the formed material. How is this fact to be accounted for on the supposition that these are mere tubes for the transmission of nutrient fluids?

In tissues which are rendered impermeable by the precipitation of calcareous matter in the formed material, and which are at the same time quickly produced and quickly removed, channels must exist for the transmission of fluids to and from the germinal matter. But in soft, permeable textures such

tubes are not required as fluids circulate freely through the interstices of the tissue or formed material.

These corpuscles and communicating tubes which are regarded by Virchow as belonging to an extensive nutrient system of tubes and cavities, exhibit very different characters in closely allied tissues. Although present in periosteum and perichondrium, they are absent in permanent and temporary cartilage. The bundles of white fibrous tissue contain, it is admitted, a vast number of them, while the substance of the elementary fibre of muscle in immediate continuity with the tendon is, at least in many instances, destitute of anything like such an arrangement; although the first tissue is one in which the nutritive changes are slight, while in the latter they are admitted to be very active.

The mucous tissue of the cord, according to Virchow, consists almost entirely of these anastomosing tubes, and there a most elaborate system for the conveyance of nutrient juices is said to exist, although with the exception of a little imperfectly formed fibrous tissue and viscid matter there appears nothing in this texture requiring nourishment. There is no secretion, and the changes occurring in such a texture must be slow. (See Page 81, and Plate V, figs. 12, 13).

They (connective tissue corpuscles) are found in connection with the capillaries of the ciliary process of the eye and those of the Malpighian bodies of the kidney in greater number than with capillaries generally. They are numerous in the cornea, in fibrous tissue, and in inflammatory lymph, and although present in some forms of cartilage they are absent in others. It is not easy to understand why they should be very numerous in some tissues situated quite close to vessels, and absent in others separated a considerable distance from the vessels. Why they should be present in some textures which undergo slight change, and absent in others where important nutritive changes must be continually and rapidly taking place. Why the soft, permeable, temporary, mucous tissue of the cord should require a wonderful nutrient system of this kind, while the hard and much less permeable cartilage is destitute of any such arrangement. Why the "cells" should be arranged in linear series in tendon and fascia, stellate in periosteum, perichondrium, and fibro-cartilage. Why the *radiating* tubes should be so distinct and so large in the mucous tissue of the cord, periosteum, and certain forms of fibro-cartilage, and so difficult of demonstration in tendon, and so narrow that the advocates of the doctrine are compelled to admit that in adult tendon the indisputably solid fibres of yellow elastic tissue are their representatives, and are

forced to support their argument with the statement, that at least at an early period of development the fibres of yellow elastic tissue are hollow? If the young white fibrous tissue, which is comparatively freely supplied with vessels, requires a special system of nutrient canals we should expect to find such canals at least persistent in the adult where the tissue is farther removed from the blood, instead of which they appear to become occluded as the necessity for their existence increases. Moreover, I have adduced instances of white fibrous tissue with parallel fibres, in which no fibres of yellow elastic tissue could be demonstrated, although the arrangement of the nuclei was the same as in other forms of this structure.

It is to be observed, however, that the stellate arrangement does exist in cases where a tissue is gradually increasing for a considerable period of time in all directions. In the cartilage of which the semicircular canals are composed in the frog, the masses of germinal matter do communicate, while in the adjacent cartilage of the temporal bone no such arrangement exists. In periosteum and in the areolar tissue of the skin, which extend in all directions, the arrangement is stellate, while in tendon, which extends chiefly in two directions, it is linear. In voluntary muscles of the system of vertebrate animals generally (with some exceptions) the masses of germinal matter are separate, while in the muscular fibre of the heart they are connected, forming lines which occupy the centre of the fibre; and I might bring forward many other facts which receive something like an explanation according to the view I have proposed, but which cannot be accounted for on the other theory. It is very hard to believe that different forms of cartilage are developed and nourished in a totally different manner. This question, however, requires further investigation.

I have endeavoured to prove, that in nutrition inanimate matter becomes germinal matter, while the latter is converted into formed material, and thus in certain cases the production of new-formed material makes up for the amount which is disintegrated. The rate at which these processes are respectively carried on will determine the increase or diminution of the texture and will materially influence its consistence and period of existence. I consider that always in nutrition the pabulum first becomes germinal matter, and that germinal matter is, therefore, always present in tissues which receive nutrient material, and not only so, but that it varies in quantity according to the activity of the nutrient process, or in other words, according to the rapidity of change in the tissue.

Certain forms of Areolar or Connective Tissue.

The areolar or connective tissue in connection with many of the higher tissues of the body appears as a delicate fibrous texture, in which the direction of the fibres is not uniform, or as a delicate transparent web, in which granules and irregular fibres are here and there seen, destitute of nuclei, and of any form of yellow elastic tissue, or associated with one or both of these latter structures. These forms are to be distinguished from the well-defined bundles of white and yellow fibrous tissue which possess nuclei, and which are found in the corium and in other situations. The structure we are now considering has been spoken of as indeterminate or indefinite connective tissue. You find it in papillæ, as in those of the tongue and skin, in connection with vessels, nerve fibres, and muscular fibres, between the follicles of glands, the uriniferous tubes, and in the brain and spinal cord, and in many other situations. It is often considered as a bond of union between different textures, and as a support to higher tissues, but it must be remembered that at an early period of development, when the tissues and parts of organs are very soft, and seem to be in greatest need of support, there is no indefinite connective tissue. Moreover, it must be quite obvious that in such an organ as the kidney the different structures support each other. The uriniferous tubes support the vessels which lie between them, and *vice versâ*.

By some it is asserted that this form of connective tissue contains cells or nuclei, while others deny this, and assert that even the higher forms of white fibrous tissue are produced independently of these structures. I have endeavoured to disprove the truth of the latter assertion, but I feel quite sure that the former statement is true. I have seen certain forms, both of white and yellow fibrous tissue, which are destitute of nuclei. The mode of formation of these structures will be presently discussed.

At an early period of development this form of connective tissue is absent. There are only traces of it in the fœtus at the seventh or eighth month, but it is found in increased quantity in the tissues of the child, and in still greater proportion in the adult. In some situations I think I have demonstrated that it increases as age advances, but at the same time it undergoes condensation, and therefore occupies less space. In disease it is often increased in situations where only traces are present in health, and it is found in situations

where it is absent in the normal state. It is frequently present in large quantity in situations from which higher tissues have disappeared.

During the process of development tissues which serve but a temporary purpose are constantly being replaced by the growth of higher and more permanent structures. The complex tissue which exists in the adult is represented in the embryo by a much more simple type, which is removed and replaced often by several series of textures before a tissue like that of the adult is produced. The tissues are not developed in their permanent form, and do not simply increase as the body grows, but those textures which perform certain functions in the adult, are represented in the embryo by tissues which perform corresponding, but not exactly similar offices. Not only have the permanent glands certain temporary substitutes, differing from them in important points, but the structure of the different tissues, muscle, nerve, bone, &c., becomes modified as development proceeds, until the permanent type of structure is reached. At the sixth or seventh month of intrauterine life it is not possible to trace the representatives of all the adult structures, in the finger, for instance; most active changes are occurring, and it is quite evident that the newly-formed tissues are growing and encroaching upon structures which attained their maximum of development at an earlier period. The nerve fibres and vessels alter as much as any other tissues. A space which in a given position in the fœtal finger contains only capillaries and terminal nerve fibres, will, at a later period, contain arteries, veins, and nerve trunks, as well as capillaries and terminal branches, and later still, will contain, and perhaps be entirely occupied with, large arterial and venous trunks, and bundles of trunks of nerve fibres. The Pacinian corpuscles, the sweat glands, and the papillæ are all to be seen, but their structures and relations are very different when development is more advanced. There are no sudden changes, no sudden transitions from one tissue to its immediate successor, but the processes take place very gradually, and the temporary tissues slowly give place to their more perfect and more permanent successors. When the perfect type has been attained, new tissue of the same kind is formed, while the old is gradually removed, and in some textures these changes proceed so quickly that elementary parts of every age are to be seen, from the earliest embryonic state to the perfect structure, and from this to the wasted remains, which enable us to complete the history of the changes which occur.

When an organ which is destined to remain throughout life has been developed, special provision is found to exist whereby the removal of its component elementary organs and the development and growth of new ones is provided for. At every period of life elementary parts and organs are to be met with in every stage of formation, and it sometimes happens that the elementary organs of the kidney, for instance, are impaired when in an embryonic state. No evidence of any change may appear for a long time, but at length the time arrives when these elementary organs should have attained their perfect state, and should be ready to perform the work of the organ. Their predecessors being worn out, and no new parts developed to take their place, the work cannot be performed, and in the case of an organ like the kidney, liver, or brain, death must result.

The fibrous capsules of organs are not composed of a form of connective tissue like fascia, merely required for protecting or supporting the structure which it encloses, but veins and lymphatics are often abundantly distributed in its substance; and in carefully prepared specimens it is not uncommon to meet with portions of the altered structure of the gland even in the very substance of the capsule. The gland substance not unfrequently adheres to the capsule so firmly that in tearing it off portions of the secreting structure are torn away with it. In certain morbid changes in the structure this adhesion is much more intimate than in the healthy state. This fact, and many others which I must not stop to discuss at present, are explained upon the view that the oldest portions of the gland structure lie in contact with the capsule, and are absorbed in this situation, certain portions which are incapable of removal in a soluble form remaining, and thus contributing to increase the thickness of the capsule.

The arteries, veins, capillaries, and nerves, like other tissues, are perpetually undergoing change, and a certain amount of connective tissue seems to be always associated with these structures. It sometimes exists in such large quantities that the important tissue lies completely hidden and embedded in it; while in young small animals, as in the young white mouse, it is in some situations not to be demonstrated. As the animal advances in age, however, this tissue appears. Delicate fibres of connective tissue are found in immediate continuity with some of the finer branches of the nerves, as I have already mentioned.

Upon the external surface of a nerve trunk there is often a considerable quantity of fibrous tissue, which is in connection

with, or at any rate adheres to, the nerves. It seems as if this had resulted from the development of masses of germinal matter similar to those which produce the nerves. The truth seems to be, that germinal matter, which in the normal state would produce a high tissue like muscle or nerve, may, under other circumstances, give rise to the formation of a degraded structure, not possessing the high endowments characteristic of these tissues, and assuming the form of the simplest and lowest normal textures.

Let me now pass round a few specimens which illustrate some of the points I have mentioned, and I think you will find that many discrepancies and conflicting statements will be explained, if we study this widely distributed form of connective tissue from the point of view suggested by the remarks I have made.

Nerves in the Skin of the Mouse.

Preparation 53 is the skin of the white mouse, seen from below. The bulbs of the hair and the sebaceous follicles arranged in rows are very prominent objects, and between them and around them in every part of the specimen are seen small arteries, veins, capillaries, and bundles of nerve fibres. As you alter the focus you see nerve fibres at every plane; several may be traced to the hair bulbs which they encircle. A nervous plexus of the most intricate character, in which it is possible to follow an individual fibre for a considerable distance, is seen in this preparation. As the magnifying power is increased a greater number of fibres come into view. Connected with the capillaries, arteries, and veins, are numerous oval nuclei, and nuclei much resembling them are seen at very short intervals along the nerve fibres. Nuclei connected with fat vesicles are also observed. Besides, there are some small spherical bodies, which I believe are either white blood corpuscles in the capillaries or lymph corpuscles. In the crowd of nuclei all the above can be recognized, but besides them there are also nuclei in connection with the fibrous tissue of the true skin. Of all these separate masses of germinal matter, or nuclei, those connected with nerve fibres and capillaries can be readily distinguished. These alone form lines which branch, the branching being of a different character in the nerves and capillaries. In some parts of the specimen the capillaries are injected, and the nuclei in their walls can be most positively distinguished from those connected with the nerves. The latter, which are very numerous, are found in connection with all nerve fibres, and

are very numerous, and situated at very short distances from each other in the terminal branches. They are not mere swellings or varicosities, but oval masses of germinal matter, which are coloured by carmine, and are as necessary to the life of the nerve fibre as those of cartilage, or fibrous tissue, or epithelium, or muscular fibre are integral parts of those structures, and necessary to their existence. The nerve fibres are very numerous in every part of the specimen, and as the fibrous tissue of the skin grows as the nerves increase, the latter gradually become embedded in it, and are with great difficulty followed out in ordinary specimens. In this preparation, bands composed of three or four trunks are seen to divide, some of the fibres passing to an adjacent band, so that a most complicated plexus is formed, and it is exceedingly difficult to find a fibre which is undoubtedly single. As the power is increased, fibres are resolved into two or three, which were not visible by the powers in ordinary use, (two to three hundred diameters).

Mucous Membrane of Fauces.

There are few structures more beautiful than those displayed in a thin section, near the surface, of a sensitive mucous membrane from man or the higher animals; but it is so difficult to demonstrate the arrangement of the delicate nervous plexuses in these tissues that the anatomy of these structures has not been fully described. Immediately beneath the epithelium of the mucous membrane of the palate, fauces, and pharynx of man, there exists the most intricate plexus of nerve fibres that can be conceived. Exceedingly thin sections are required, and I have found practically that these may be more easily obtained from the mucous membrane covering the epiglottis than from that of other parts. After the parts have been injected with Prussian blue fluid, the epiglottis is removed, treated with carmine, and preserved in glycerine. The mucous membrane adheres pretty firmly to the cartilage beneath. With a very sharp thin-bladed knife the layer of epithelium may be removed in such a manner that the surface of the subjacent membrane is completely exposed in some places, while in others a very thin section of the deepest layers of epithelium remains, and here and there a thin section from the surface of the mucous membrane itself will have been removed. Next, the thinnest possible horizontal section is removed parallel to the cut even surface, and transferred to glycerine. After being carefully covered with very thin glass, the specimen is examined with a power of from five to eight hundred diameters. In favourable

specimens an arrangement of nerve fibres so wonderful is brought into view, that the observer will examine the specimen again and again before he can convince himself that what he seems to see, is real. Flattened bands, composed of from two to five or six nerve fibres, are seen crossing the field in every direction, and in the small intervals between them, finer and still finer branches are brought into view by careful focusing. Some of the fibres are of very large size, but others, in their general appearance, very closely resemble the gray, or gelatinous, nerve fibres. It is possible that some few of the fibres observed may be muscular fibres of the mucous membrane, but there cannot be the least doubt, that by far the majority are nerve fibres, which form a most intricate interlacement immediately beneath the epithelium. Moreover, it is to be noticed that there are at least two kinds of nerve fibres in this situation. Although many of the finest fibres are probably the terminal ramifications of branches which are thicker at a distance from their termination, there can be no doubt that the widest fibres are distinct from these altogether, and are not in any way connected with them.

Here and there the nerve fibres may be seen to divide, but from the great number present it is often difficult to isolate an individual fibre in which the division may be seen very distinctly. I believe the divisions of dark-bordered nerve fibres occur pretty frequently. In the palate of the frog, however, where the nerves are very numerous, but not nearly so abundant as in the human subject, this point is demonstrated without great difficulty.

In specimens from which the epithelium has been removed by gentle scraping instead of by section, little papillæ may be seen, and into these nerve fibres may be traced. The branches are seen to be bent upon each other in several places, and may be said to form a loop, the fibres of which are bent sharply at short intervals, so that the body of the papilla is twice or three times as wide as its neck where the nerve fibres pass into it. Several of these papillæ, as far as I could ascertain, were destitute of capillary vessels, but it is possible that very fine capillaries may have existed, which, from not having been injected, were not demonstrable. The papillæ above described may be regarded as a more simple form of the tactile corpuscle present in the papillæ of the fingers, toes, lips, &c. Beneath the plexus, above described, are larger bundles of nerve fibres, with vessels and much yellow elastic tissue. Connected with these nerve fibres are many ganglion cells, and here and there a microscopic ganglion.

The existence of small ganglia and ganglion cells in connexion with the nerves of this and some other mucous membranes is a point of great interest and importance, especially when considered in connexion with their absence beneath the skin. Beneath the mucous membrane of the pharynx and palate of the frog, ganglia and ganglion cells are present in great number, but, have never seen one connected with the cutaneous nerves.

Oval nuclei or masses of germinal matter are very numerous, and are seen at very short intervals in all the nerve fibres. They are most numerous in connexion with the finest nerve fibres. They are also numerous on the vessels, as in other parts. In a carelessly prepared specimen nothing but these numerous nuclei, which appear to be embedded in a slightly fibrous intermediate structure, are observed. Not a nerve fibre is to be made out in some specimens prepared in the ordinary manner, and were I even to alter the density of the glycerine in the specimens I have passed round (Preparations 54 and 55), the appearance, now so distinct, would at once be lost.

In some places, from carelessness in manipulation, the distinctness of the nerve fibres is lost, and in these situations the nuclei are seen in connexion with very fine fibres, not altered by acetic acid, and resembling in all respects yellow elastic tissue. In the external coats of arteries and in the pericardium, similar appearances have been observed, and from these and other facts, which I shall allude to in a separate communication, I think that certain forms of yellow elastic tissue are the remains of nerve fibres, and perhaps other structures which were in a state of activity at an earlier period of life.

Pericardium, its Nerves and Ganglia.

Preparation 56 is the pericardium of the human fœtus at the seventh month removed from the surface of the heart. The capillaries have been injected with Prussian blue. The bundles of nerve fibres are seen crossing the field and dividing and subdividing into smaller bundles, so that a network of nerve fibres with wide meshes is formed. Numerous oval nuclei are observed at short intervals in connection with all the fibres forming these bundles. The distribution of the finer branches cannot be made out definitely because the fibres, except when a great number are placed together, appear perfectly transparent. Fibres of white and yellow fibrous tissue

can be detected in this specimen, but the quantity of connective tissue present, is very small compared with that existing in the adult pericardium.

In Preparation 57, ganglion cells and large bundles of gray, gelatinous, nerve fibres are seen. These have been dissected or from the pericardium of the ox. Three separate ganglion cells situated at the side of the nerve fibre have been placed in the field, and each ganglion cell is surrounded with bands of nerve fibres resembling those of which the trunk of the nerve is composed. Nuclei exactly resembling those in the fibres are seen embedded in the substance of the ganglion. (Plate IX, figs. 40, 41, 42).

From this and other appearances one cannot but conclude that the fibres are continuous with the ganglion cells, and are developed from them. The nuclei being formed in the substance of the ganglion cell, as well as subsequently by the division of those connected with the fibres. I believe that the nerve fibre with its nuclei may be regarded almost as an extended ganglion cell. Each ganglion cell is connected with several nerve fibres, and the so-called capsule of these cells, generally described as consisting of areolar tissue, is really composed of nerve fibres which wind round a considerable part of the circumference of the cell, and then divide into bundles, which pass in different directions. The nuclei which are described as the nuclei of the areolar tissue capsule are the nuclei of the fibres and exactly resemble those in unquestionable nerve fibres. Those nerve fibres embedded in the substance of the pericardium seem to contain no tubular or dark bordered nerve fibres, (fibres with the white substance of Schwann).

On the external portion of these bundles of nerve fibres in the adult and surrounding the ganglia, a considerable quantity of areolar or connective tissue generally exists, and very commonly the quantity is so great that the nerve fibres and ganglia are obscured by it. Preparation 58 is a microscopic ganglion embedded in the areolar tissue, just outside the base of the aorta near its origin, from the human subject, and Preparation 59 is a ganglion embedded in the adipose tissue from the left ventricle of the heart of the pig. The ganglia are numerous in the grooves between auricles and ventricles in the pig's heart, but they are so completely embedded in the adipose tissue that it is only by making thin sections one after the other that they can be discovered. I have also found numerous microscopic ganglia in corresponding situations in the human heart.

These preparations prove that the pericardium contains numerous very fine bundles of nerve fibres which form a net-

work situated at the deep aspect of the fibrous pericardium, and on the surface of the muscular fibres. The branches are much more numerous in and near the longitudinal groove of the heart, and the grooves between auricles and ventricles, but many can be demonstrated over the general surface of the ventricles. At short intervals bundles can be seen to dip down in the spaces in which the vessels also pass, and these from their transparency are soon lost amongst the muscular fibres. Numerous microscopic ganglia, resembling those of the sympathetic, are connected with many of these nerve fibres. In some cases, collections of ganglion cells are seen at the side of the nerve fibre, and in many instances two or three ganglion cells can be made out in the very substance of the trunk. These microscopic ganglia are demonstrated without difficulty and in immense number, in properly prepared hearts, but from the fact that most of them are embedded in adipose and in areolar tissue, they are very liable to be overlooked. They are most numerous at the base of the heart in the grooves between the auricles and ventricles, in the longitudinal grooves, and in the areolar tissue at the base of the large arteries, and in that surrounding the arteries themselves.

In the muscular substance of the heart, the fine branches of the nerves may be followed. Their general disposition resembles that in voluntary muscle, and, as the nuclei of the muscular fibres of the heart are in the very centre of the fibre, there is no fear of mistaking these for the nuclei of the nerve fibre. Many nerve fibres are distributed to the vessels, but by far the greater number certainly ramify on the surface of the muscular fibres. It is impossible to demonstrate these latter points unless the vessels have been, in the first instance, carefully injected with transparent fluid.

The preparations I have shown you compel me to differ from the general opinions now entertained, with reference to the nature of the so-called gelatinous, or gray, fibres. The distribution of these fibres seen in the pericardium, their connection with the ganglia, their constant appearance, the numerous nuclei connected with them, are all incompatible with the notion of their consisting merely of bundles of connective tissue. I can very easily show that many of these fibres are the only fibres connected with most unquestionable ganglion cells, and those who still maintain such fibres to be connective tissue, will, I think, find it very difficult to account for the presence of the ganglia in the number in which they are found in connection with this supposed fibrous tissue. I hold with Remak, and with Todd and Bowman, in this country, that

these gray fibres are veritable nerve fibres, and must be altogether removed from the connective tissue series; moreover, I must add in connection with this question that the branches of almost all, if not of all, nerves near their termination partake of the characters of the gray, or gelatinous, fibres.*

It must be borne in mind, that ganglia are much more abundantly distributed in the body than is generally supposed. Besides the well known sympathetic ganglia, visible to the unaided eye, microscopic ganglia of the same kind are very numerous, and in many of the trunks of the nerve fibres distributed to internal organs, small collections of ganglion cells, and even a single cell, are not uncommonly seen. Connected with the nerves in the palate of the frog are numerous ganglion cells, and I have found several in connection with the nerves distributed to the vessels of the same animal. They are found in the nerves distributed to all the viscera.

My researches on this subject are not yet sufficiently extensive, to enable me to express myself positively on this point, but I think it will prove that the only fibres connected with these round or oval ganglion cells of the sympathetic system, are the gray, or gelatinous, fibres. I have already shown that the oval nuclei are more abundant in fibres of which the trunks of the sympathetic are composed, than in other nerve fibres. Arguing from the inference deduced from observations upon the distribution of the nuclei in nerves generally, that they are the structures by which nerves are brought into relation with other tissues, the gray fibres and ganglia connected with them must be regarded as belonging to a nervous system which forms a complicated network, the branches of which extend to every part of the body, and which contains numerous centres presiding over the action of certain parts, but connected with other centres of this system in such a manner that the action of the whole is harmonized. Many of the sympathetic ganglia are connected with the cerebro-spinal system of nerves, but perhaps not so that the sympathetic can be said to *arise* from any part as from a centre. The experiments of Budge and Waller, and others, however, favour this view. I believe that from any part of one of the gray fibres, branches may grow which will place the parts to which it is distributed under the influence of the ganglia with which the nerves are connected. For instance, suppose a certain number of these fibres distributed to an artery, which gradually becomes larger, and from which an increasing number of branches proceeds. Every one of these will be supplied with

* On the Distribution of Nerves to the Voluntary Muscles.—Phil. Trans., 1860.

nerve fibres which will grow from the original bundle. In proportion as these branches increase the trunk and the ganglion, or ganglia connected with it, will increase. The nuclei of these fibres like those of all nerves near their distribution, undergo division and subdivision, and thus new fibres are formed according to the requirements of the part. You cannot separate a small band of gray fibres into separate individual fibres, nor can you divide the terminal branches of a cerebro-spinal nerve into distinct and separate fibres. Many of the finest fibres exhibit an indication of being composed of two or more, and this division seems to be continually going on in the peripheral branches of all nerves, and occurs in the trunks of the sympathetic system. Time will not permit me to dwell longer on this important question, but I hope to work it out shortly more in detail.

Voluntary Muscle.

Connective tissue exists between the elementary muscular fibres of the voluntary muscle of man and animals, and it has been considered as a constant structure, and subservient to certain important purposes, in this situation. The proportion of this connective tissue varies greatly in the voluntary muscles of different animals, and in those of the same animal at different ages. During the early period of development of muscle this connective tissue is not observable, and in the muscles of small animals, such as the mouse, only traces are to be demonstrated. The elementary fibres of the muscles of the young mouse seem to be quite destitute of connective tissue. On the surfaces of the elementary fibres of all voluntary muscles, at all periods of life, are a number of oval corpuscles or nuclei, and these are found in cases where very much connective tissue is observed, and also when no traces of this structure can be found. They are generally considered to be nuclei of the areolar or connective tissue, and are the bodies regarded as "connective tissue corpuscles."

No. 61 is a preparation showing the muscular fibres of the diaphragm of a young white mouse with their nerves, capillaries, and the numerous nuclei connected with them. The preparation is destitute of connective tissue, and all the corpuscles are connected with the capillaries, which are injected, with the nerve fibres, or with the muscular tissue itself.

GENERAL REMARKS ON AREOLAR TISSUE.

A certain form of connective tissue not unfrequently results from the imperfect development of elementary parts from which a much higher tissue might have been produced.

In No. 44, some of the bundles of muscular fibre cells at the edge of the uterus of the mouse are seen, and those situated most externally are observed to differ from those in the more central part of the bundle. The formed material of these marginal elementary parts presents the appearance of ordinary fibrous tissue. A corresponding fact is observed with regard to the bundles of gray nerve fibres. The nuclei situated at the outer part of the bundle do not produce nerve fibres, but they give rise to the formation of a kind of connective tissue only. Up to a certain period of their existence nerve fibres might have been produced, but as a sufficient number had been developed, these marginal cells degenerated and led to the production only of a low form of tissue.

I have shown that fibres of connective tissue are very often connected with the terminal branches of nerve fibres, and this is especially the case in old tissues which are abundantly supplied with nerves. This point can be demonstrated in the frog's tongue to such an extent that it would not, I think, be possible to pronounce in certain cases, if a given fibre were in a state of functional activity as an integral part of the nervous system, or were merely a degenerated nerve fibre no longer active, and consisting of what might fairly be termed a form of connective tissue. The question can, however, always be determined by the presence or absence of the little oval nuclei or masses of germinal matter.

In many instances, I have been able to prove that these fibres in connexion with active nerve fibres were not acted upon by acetic acid, and beneath the plexus of nerves on the surface of the mucous membrane of the epiglottis were numerous parallel fibres exhibiting the reaction and general characters of yellow elastic tissue, and amongst the undoubted nerve fibres were fibres of the same description destitute of nuclei. Similar appearances have been observed in the papillæ of the human skin and tongue. It would seem, then, that by the alteration of nerves and capillary vessels, certain forms of 'connective tissue' are produced, and this has been observed in many different situations and in different animals, man, mouse, cat, frog, and others.

In the dura mater, the coats of small veins have been seen gradually thickening, until they were converted into solid bundles of fibrous tissue, and many have been seen with an exceedingly narrow cavity in the centre corresponding to the calibre of the vessel.

The alteration of nerve fibres into fibrous tissue has been very carefully watched in many localities. In the human organism the sole difficulty in following out the distribution of the nerves arises from this cause. Fibrous tissue also forms the remains of many other structures, in fact, the variety of this tissue which we are now considering is composed of the remains of various structures which cannot be entirely removed by absorption. The areolar tissue between the ultimate follicles of glands, that which surrounds vessels and nerves, and the fibrous tissue of which the so-called capsule of certain organs, liver, kidney, spleen, &c., are all of this nature. No wonder that in man, whose tissues pass through so many stages before he arrives at maturity, and in whom such active changes occur after this period, there should be a large amount of this structure. This form of fibrous tissue is absent in the embryo at an early period, exists in very small quantity in the young child, and the proportion gradually increases as age advances. In small animals there is less than there is in large animals, and in young animals there is less than in old animals. In creatures of the simplest organization, whose tissues are, so to say, embryonic throughout the whole period of their existence, there is none. In the higher animals whose tissues pass through so many phases before they attain their perfect form, there is a large quantity. A form of connective or areolar tissue is the result of certain degenerative processes occurring in higher tissues. It may result from changes occurring in vessels, nerves, and muscles. In various glandular organs which have undergone degeneration, a form of fibrous tissue remains behind. In cirrhosis of the liver, I believe the fibrous matter which is present results not from the effusion and fibrillation of lymph, but is simply the remains of the degenerated capillaries and ducts. In livers in this condition, vessels and shrunken secreting structure, can always be demonstrated in the substance of the so-called fibrous tissue. The same remarks also apply to the kidney in certain cases of disease, and to other glandular organs. The structure of inflammatory lymph has been already described. This gradually undergoes a process of condensation and a form of fibrous tissue at last results.

I must now make a few remarks upon certain fallacious

appearances which may be produced by the mode of preparing specimens of healthy tissues, and which may easily be mistaken for fibrous tissue. I have already adverted to this matter in my first lecture; I have seen the smaller blood-vessels, both arteries and veins, stretched in one part of their course so that the transparent injection was pressed out of the transparent tube, while its continuity with the other parts containing the blue injection was perfectly certain. Had I seen the stretched portion alone, I should have affirmed most positively that it was a form of areolar tissue, and the nuclei which belonged to the structure forming the coats of the vessels might have been considered to be the nuclei of the areolar tissue.

Delicate nerve fibres when stretched and pressed could not be distinguished from connective tissue. Under the same circumstances, capillary vessels and the membranous walls of ducts may be set down as 'areolar or connective tissue.'

It would seem, then, that there are—

1. Certain forms both of white and yellow fibrous tissue which are produced directly from germinal matter as other tissues, and in which masses of germinal matter may be demonstrated at every period of life.

2. Certain forms which may be regarded as the residue of higher tissues which have ceased to discharge active functions.

3. Certain forms of fibrous tissue (indefinite connective tissue), as in the papillæ of touch and taste, which result from changes having occurred in the terminal branches of the nerve fibres.

4. Certain forms of fibrous tissue, resulting from degeneration occurring in the course of disease (abnormal).

5. An appearance of fibrous tissue produced by pressure, crumpling, and stretching of nerves, capillaries, and other tissues.

You will have gathered from the observations I made when the last preparations were sent round, that I consider, for instance, in a structure like skin, that a number of bodies, taking part in the formation of special tissues, have been dismissed under the term 'connective tissue corpuscles.' The following bodies, composed of germinal matter and generally termed nuclei, are certainly present:—1. Nuclei of nerves. 2. Nuclei of capillaries. 3. Nuclei of white fibrous tissue. 4. Nuclei of yellow fibrous tissue. 5. Nuclei of fat cells. 6. Lymph, and white blood, corpuscles. In certain papillæ all the nuclei present may be shown to belong to nerves and capillary vessels, and between the elementary muscular fibres

of the young mouse this is also strictly true. I do not think that in such situations there are any corpuscles which could properly be called areolar tissue corpuscles, nor have I succeeded in obtaining any facts which would favour the view that there are corpuscles of any kind distinct from the 'cells' or 'nuclei' (germinal matter) of the tissue, which perform special offices connected with the nutrition of these higher tissues.

General Remarks and Summary of Conclusions.

In this course of lectures I have endeavoured to prove that the changes which more especially distinguish living structures from lifeless matter, take place in the substance I have termed *germinal matter* and in this alone. The particles of which this is composed after passing through certain definite stages of existence, undergo conversion into the peculiar substance or substances they were destined to produce. It is the germinal matter alone which is capable of *forming, producing* and *converting*. The matter external to it (cell wall, intercellular substance or fluid) has *been formed* or *produced,* and it may be changed, but it has no power to *produce* structure or to alter itself.

There are many objections to the use of the term 'cell' as indicating the elementary unit of structure. The cell-wall is not constant although it is absolutely necessary to the existence and action of the 'cell,' that is, in the sense in which this word is ordinarily used. There are comparatively few instances in which a true vesicle exists at all.

Every living structure, and every elementary part that is living, is composed of matter which is *forming* and matter which is *formed*—germinal matter and formed material. The term cell is short and convenient and if the definition usually given were modified, I think it would possess advantages over the term 'elementary part.' We might give the word a much more general signification and say that a 'cell' is composed of matter in two states which I have described under the terms germinal matter and formed material.

It appeared to me that great confusion would have resulted if I had attempted to show when describing various structures the exact parts which according to the ordinary nomenclature corresponded to my 'germinal matter' and 'formed material'

and I have therefore purposely omitted to discuss the question at all in detail. It may, however, be well to state now that in some cases the *germinal matter* corresponds to the 'nucleus,' in others to the 'nucleus and cell-contents,' in others to the matter lying between the 'cell-wall,' and certain of the 'cell-contents;' while the *formed material,* in some cases corresponds exactly to the 'cell-wall' only, in others to the 'cell-wall and part of the cell-contents,' in others to the 'intercellular substance,' and in other instances to the fluid or viscid material which separates the several 'cells, nuclei or corpuscles,' from each other. It may be remarked—

That the 'nucleus' of the frog's blood-corpuscle is *germinal matter;* the external red portion (cell-wall and coloured contents), *formed material.*

That the white blood corpuscle, the lymph and chyle corpuscle, and the pus and mucous corpuscle, are composed entirely of *germinal matter,* with a very thin layer of *formed material;* the viscid matter or mucus between the mucous corpuscles is *formed material.*

That the 'nucleus' of an epithelial cell of mucous membrane, or of the cuticle is *germinal matter;* in a fully formed 'cell' the outer part, 'cell-wall and cell-contents' consists of *formed material.*

That the 'cell-wall' of a fat-cell or of a starch-holding-cell is *formed material;* the 'nucleus' of the former, and the 'primordial utricle' of the latter, are *germinal matter;* while the fat and the starch are the secondary deposits produced by changes occurring in particles of germinal matter in the central part of the mass.

I have chosen the terms 'germinal matter' and 'formed material' because they serve to express the essentially different nature of the two forms of matter of which every elementary living structure is composed at the time it is under observation. I do not think that it is possible for any living particle to exist without being composed of matter in these two states,—matter capable under favourable circumstances of producing germs from which new germs may be developed infinitely,—and matter which once possessed this power but which has been formed or converted into a substance endowed with certain peculiar and important properties, it is true, but now totally destitute of the power of producing matter like itself, reproduction, &c.

It may be remarked that by the use of these terms alone, the changes taking place in the development, growth, and nutrition of tissues in health as well as in disease may be

described. I have endeavoured to study and describe *actions* and *changes* rather than to give names and definitions to structures which exist at any given period, but which are in a state of constant though gradual and perhaps very slow change. To aim at giving a history of the changes which occur seems to me more likely to lead to useful results than to attempt to define arbitrarily the limits of structures between which there is in nature no observable line of demarcation. In many cases the *germinal matter* passes gradually into the *formed material*, and it would be impossible to describe these by using the ordinary terms,—for there are no means by which we could determine positively which part of the structure was *cell-wall*, and which *cell-contents*. I may, however, be permitted to say that I am quite ready to modify the terms employed, in any way which may be likely to render them more convenient or more useful.

No attempt has been made to define exactly what is an *individual*. It seems to me that as the several component parts of the organism of the higher animals are dependent upon each other for their existence, we cannot look upon any one elementary part as an *independent growing living structure*. The conditions necessary for its existence are such that it cannot live when detached. On the other hand the contents (germinal matter) of what appears to be an elementary part (cell) of a simple fungus may be divided perhaps into many thousand particles, every one of which is capable of existing independently, of growing infinitely, and of producing a structure resembling that from which it has sprung. I have brought forward evidence favourable to the view that living particles exist which are far too minute to be seen by any magnifying powers which have yet been made. Again, there are many instances in which division can be carried to a certain degree of minuteness with the production of a multitude of living particles, each one of which grows into a structure resembling that of which it was but a small part. But if the structure be divided into more minute particles the death of all results. The simpler the conditions necessary for existence the more independent are the several parts or particles of which an organism is composed. As far as structure is concerned, an elementary part of a fungus corresponds to an elementary part of one of the higher tissues. The germinal matter of each is capable of growing infinitely and may be divided into numerous smaller particles, each one of which is capable of growth, but the conditions necessary for maintaining the vitality of the fungus are so simple that each particle will live although separated from its

neighbours and exposed, within certain limits, to variations of temperature, moisture, &c. The particles of the germinal matter of the elementary part from any tissue of one of the higher animals, will only live when in contact with the fluids of the body which produced it or those of another body of the same kind. It cannot exist independently for any length of time and if the conditions under which it is placed normally, be very slightly altered, it dies. Under no circumstances can it produce an independent organism. Neither a portion of germinal matter nor an entire elementary part of a tissue of one of the higher animals can be regarded as an independent structure. It is only a part of an individual whole. On the other hand, a very small portion, far too minute to be seen by the highest powers, of one of the simplest and lowest forms of existence is independent, may produce, though isolated, a structure similar to that from which it sprung and may be regarded as an individual. The higher organism is composed of an immense number of elementary parts which are dependent on each other and cannot exist separately. An elementary part of the simplest organism is composed of an immense number of minute particles every one of which may live and grow and produce its kind independently of its neighbours and of the stock from which it was derived.

It will be inferred that I hold that vital power is not generally diffused over tissues but is restricted to the particles of the germinal matter only. Often a very gradual transition may be traced from the particles of germinal matter to the formed material. It is not possible to define the exact point at which a particle ceases to possess the power of animating lifeless matter and acquires the properties of the formed material. The change is a gradual one. Probably for a certain period particles possess the power of growing rapidly, dividing and sub-dividing into multitudes of new ones. Next the power becomes more restricted. They may divide into two, and the process may continue in the resulting parts, but at length this ceases and the particles become converted into the material, the production of which is the end for which they lived and were produced. One might say therefore that the vital activity of the particles gradually becomes reduced as they recede from the centre at which they became animated. If the term life and vital activity be used, several degrees must be admitted. The particles seem to pass by almost insensible gradations from the highest point of vital activity to a state from which they pass uninterruptedly towards a comparatively quiescent condition which is followed by death and disinte-

gration. Changes in chemical composition as well as in physical properties are associated with the different phases of existence. During the life of the particles as germinal matter, the arrangement of the elements must be altered in such a manner that new combinations may take place while the change into formed material proceeds. It is probable that very many substances of definite composition are produced and undergo conversion into other compounds during these changes.

The most important points which I have endeavoured to prove in this course of lectures may be summed up as follows.

1. That the smallest living elementary part of every living structure is composed of matter in two states, *forming* and *capable of increase,* upon which the active phenomena are entirely dependent,—and a substance external to this, which existed at an earlier period in the first state, but which is now *formed,* and destitute of the powers above referred to.

2. That the only part of a living structure which possesses the power of selecting pabulum and transforming this into various substances of growth, and of reproduction, is the active substance or *germinal matter.*

3. That the germinal matter possesses the power of growing infinitely but that it always grows under certain restrictions. The rapidity of its growth or extension is determined by certain conditions.

4. In all living beings the matter upon which *existence* depends is the germinal matter, and in all living structures the germinal matter possesses the *same general characters* although its *powers* and the *results of its life* are so very different.

5. An increase in the *number* of elementary parts always results from the division and subdivision of the masses of germinal matter. In many cases portions project some distance from the general mass and then become detached.

6. A mass of germinal matter which is endowed with powers different to those of the germinal matter from which it was derived, always originates as a new centre (nucleus or nucleolus) in pre-existing germinal matter. The origin of new centres is from within centres, or endogenously, but the mass of germinal matter which results multiplies by division.

7. During the life of every elementary part, a movement of the particles of the germinal matter takes place in a definite direction, from centre to circumference, and it is probable that by this movement of the particles *from* centres, the transmission of the nutrient substances in the opposite direction is ensured.

8. The relative proportions of germinal matter and formed

material vary greatly in different elementary parts, in the same elementary part at different periods of its growth, and in the same tissue under different circumstances. The more rapidly growth proceeds, the larger the absolute amount of germinal matter produced in proportion to the formed material. Rapidly growing structures are *soft* and *easily disintegrated.* Firm dense tissues are of slow growth, and the hardened *formed material* of which they mainly consist, resists disintegration and change.

9. The pus-corpuscle is a mass of germinal matter in direct descent from the germinal matter of an elementary part. The conditions under which the growth of the germinal matter has taken place have been such as to cause its rapid increase, and to interfere with the production of formed material. For some time before perfect pus-corpuscles were produced, a tendency to the production of elementary parts, like those of the original texture, was manifested.

10. The cell-wall is not a constant structure. The definitions generally given of the cell are not applicable to the elementary parts of many tissues. Pabulum does not pass through the cell-wall to become altered by the action of the cell, but certain of its constituents are converted into germinal matter,—the living substance which becomes tissue or is changed into substances which form the constituents of secretions.

11. In the nutrition of an elementary part the following phenomena probably occur. 1. Inanimate pabulum passes through the formed material into the central portion of the spherical masses of germinal matter, while, 2. Particles previously animated move outwards. 3. The outermost particles of the germinal matter become converted into formed material. 4. A corresponding quantity of the oldest formed material is disintegrated, or the new formed material is added to that previously existing, in which case this structure increases in quantity. In *nutrition,* without growth, an amount of inanimate matter becomes living germinal matter within a given time, exactly corresponding to the proportion of germinal matter which undergoes conversion into formed material, and this makes up exactly for the quantity of old formed material, which being no longer fit for work, is disintegrated, converted into soluble substances, and removed.

Connective Tissues.

12. The connective tissues as a class cannot, by any structural characters, be separated from other tissues of the body.

13. The chief differences between a structure like epithelium (cell tissue) and cartilage or tendon (connective tissue) are these. In the first, the formed material of each elementary part is more or less separated from that of its neighbours, while in the latter the formed material is continuous throughout, but in both cases, the oldest portion of the formed material is that which is farthest from, and the youngest, that which is nearest to, each mass of germinal matter.

14. White fibrous tissue and cartilage do not consist of *cells,* and an *intercellular substance* which is produced independently of cells; but the so-called intercellular substance exactly corresponds to the cell wall of an epithelial cell, and, like this, was produced from the masses of germinal matter (cells). No 'intercellular substance' is produced independently of the living active granular substance in the 'cell,' or *germinal matter.*

15. The 'nuclei' or masses of germinal matter of tendon correspond to the 'nuclei' of an epithelial cell. The fibres of yellow elastic tissue in tendon are neither connected with, nor formed from or by, these 'nuclei.' The matter of the 'nuclei' gradually undergoes conversion into the white fibrous tissue, while new nucleus or germinal matter is produced from the pabulum.

16. The 'mucous tissue' of the umbilical cord is a modification of fibrous tissue. No system of communicating tubes for the circulation of nutrient juices can be demonstrated in it.

17. In certain tissues (cartilage, epithelium) the masses of germinal matter produced by division are quite separate and distinct from each other, while in others (tissue of umbilical cord, tendon, periosteum, &c.) they remain for some time connected together. Thus a thread-like or stellate arrangement may be produced, and as the several masses become further separated, the points of communication are reduced to narrow lines and often disappear altogether.

18. The osseous tissue is composed of formed material which is afterwards impregnated with calcareous matter, and corresponds to the matrix of cartilage and to the wall of an 'epithelial cell,' as for instance that of a 'cell' of cuticle.

19. The lacunæ of living bone are occupied with germinal matter (nucleus) and formed material, in which calcareous particles are still being deposited from withouti nwards.

20. The canaliculi are mere spaces which are left during the accumulation of calcareous matter in the formed material. Through these channels fluids pass to and from the germinal

matter in the lacunæ. They are not *processes which grow,* but are merely *channels which are left.*

21. No dentinal *'tubes'* exist in living dentine. The 'dentinal tube' like the lacuna, contains germinal matter and formed material, and the latter is gradually impregnated with calcareous matter from without inwards,—that is, the oldest formed material first undergoes the process of calcification.

22. The so-called gray or gelatinous fibres are real nerve fibres, and there are many ganglia which are connected with these fibres alone. The ultimate ramifications of all nerve fibres closely resemble the gray or gelatinous fibres. These fibres are numerous in the pericardium and are distributed to all the vessels.

23. Certain forms of connective tissue may result from changes taking place in nerves and vessels. The modification of connective tissue met with in the papillæ of taste and touch, is probably, in great part, the remains of nervous structure which is incapable of being removed by absorption. Certain forms of connective tissue are produced by germinal matter but some varieties consist of the remains of structures which were active at an earlier period of life.

24. In some situations in which 'areolar tissue corpuscles' are said to exist, and to form a *special system of tubes and cells* connected with the *distribution of nutrient juices,* the following bodies may be recognized; nuclei of *nerves,* nuclei of *capillaries,* nuclei of *white fibrous tissue,* nuclei of *yellow fibrous tissue,* nuclei of *fat cells, lymph,* and *white blood-corpuscles.* Each of these masses of germinal matter is connected with the production of its own peculiar tissue or formed material, and there are no cells and tubes to be demonstrated which are concerned in the distribution of nutrient matter to these textures. The nutrient fluid permeates the tissue generally, and each mass of germinal matter selects its proper pabulum and undergoes increase, while the older particles undergo conversion into tissue.

ON THE SOLVENT POWER OF STRONG AND WEAK SOLUTIONS OF THE ALKALINE CARBONATES ON URIC ACID CALCULI.*

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Abstract.

THE design of the author was to show the fallacy of certain experiments that had been made on the solubility of uric acid calculi in solution of the alkaline carbonates; and to furnish some exact data from which to estimate the rate at which it is possible to effect solution of these calculi by alkaline carbonates.

About twenty years ago, the French Academy appointed a Commission, composed of MM. Gay-Lussac and Pelouze, to inquire and report on a number of conflicting communications that had been made to it by the advocates of solvents for urinary calculi and their opponents.

This Commission reported, in 1842, to the following effect. They had exposed numerous urinary calculi for a whole year to the contact of solutions of the alkaline carbonates, containing from 273 to 546 grains to the pint. None of the calculi were dissolved; and some were not diminished in bulk. Their loss of weight varied from a quarter to one-half.

In another experiment they passed, in the course of three months, 110 gallons of a solution containing a twentieth of its weight of carb. soda, over a number of fragments placed at the bottom of a glass funnel. The bulk of most of these was not diminished, and their loss of weight varied from 10 to 60 per cent.

They then tried experiments on the living body, by passing currents of the solvent through the bladder at blood heat by the double catheter. Here is a sample of their results. A patient who had been subjected to lithotrity, and whose stone

* This is the abstract of a paper read at the Meeting of the British Association for the Advancement of Science held in Manchester, 1861.

was known to be uric acid, had, at different times, 55 gallons of a solution of carb. soda, containing 130 grains to the pint, passed over a large remaining fragment, which had been carefully measured. This enormous mass of liquid produced no diminution in the bulk of the fragment; its only effect was to soften the surface.*

The conclusions of this report were wholly adverse to the advocates of solution; and they were formally adopted by the Academy.

The experiments, however, have a defect: the solutions used were too concentrated, and this circumstance vitiates the whole inquiry. The author found that very weak solutions of the alkaline carbonates dissolved uric acid calculi with considerable rapidity, while stronger ones altogether failed. In order to decide what strength of solution had the most solvent power, fragments of uric acid, weighing from 40 to 112 grains were placed in 10 oz. phials, and solutions of carbonate of potash and soda of various strength were passed over them at blood heat. The experiments were continued day and night; and the daily flow of solvent varied from 6 to 15 pints.

Operating in this way, it was found that above a strength of 120 grains to the pint there was no dissolution; and even with 80 grains to the pint there was only a little; but solutions of 50 and 60 grains to the pint dissolved the fragments freely. The cause of this difference was found to lie in a coat or crust of white matter which invested the stone in the stronger solutions. At and above 120 grains to the pint this coat was dense and tough, and could not be wholly detached from the subjacent surface. With 80 grains to the pint, it was brittle and easily detached like a layer of whitewash. With 60 grains to the pint and under, either no crust formed at all and the stone dissolved clean with a water-worn appearance, or it was only represented by a few loose flakes, scattered here and there over the surface, and offering no impediment to dissolution. This coating or crust was found essentially to consist of bi-urate of potash or soda, and its formation depended on the fact that the alkaline bi-urates are almost insoluble in any but very weak solutions of the alkaline carbonates. In the strong solutions the bi-urate remains undissolved and encases the stone in an insoluble investment; while in weaker ones it is dissolved as fast as it is formed, the surface of the stone remains clean, and dissolution proceeds without impediment.

The following tables are the results of forty-eight day experiments :—

* Comptes Rendus, 1842, p, 429.

Table I.—*Uric Acid and Carbonate of Soda.* (*Sod. Carb. exsiccat of the shops.*)

Strength of Solution.	Flow per 24 hours.	No. of Obs.	Daily average Loss of Weight per Cent.	Remarks.
Grs. per pint.	Pints.			
240	6	2	0	Covered with a dense coating of bi-urate.
120	6	2	0	Covered with a dense white coat.
60	14	2	14·3	Covered with a looser white crust, which was removed before weighing.
30	15	4	10·9 } 10·3	
30	8	2	10·2 } 10·3	Dissolved clean.
30	5	2	9·8 } 10·3	

Table II.—*Uric Acid and Carbonate of Potash.*

Strength of Solution.	Flow per 24 hours.	No. of Obs.	Daily average Loss of Weight per Cent.	Remarks.
Grs. per pint.	Pints.			
240	6	1	0	Covered with a tenacious white coat as if of paint.
120	6	3	0	Covered with a less dense coating. After detaching this and wiping, there was a mean loss of weight of 7·1 per cent.
80	6	2	9·8	Covered with a loose detachable white crust.
60	14	2	19·0 } 20·2 ..	Surface clean.
60	6	5	21·4 } 20·2 ..	Loose flakes in spots.
40	6	3	15·6	Sometimes a few loose flakes where the fragment rested.
30	15	4	13·0 } 11·9	
30	8	2	15·0 } 11·9	
30	4	2	9·5 } 11·9	Dissolved clean; occasionally a few loose flakes.
30	6	4	10·2 } 11·9	
20	6	3	11·0	Dissolved clean.
10	6	3	6·5	Ditto.

ON DIABETES INSIPIDUS.

By Peter Eade, M.D. (Lond.)
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IN Vol. II. of this journal I published a short paper on the subject of Diabetes Insipidus, in which a case of this disease was related, and some remarks were appended in reference to the probable nature of the disorder. I also there reported the principal *post mortem* appearances observed in another and fatal case that had fallen under my notice. Since that time two or three further examples of this affection have occurred in my practice, and as one of them has ended fatally whilst under my care, I desire now to record and call attention to the unusual condition of the kidneys, and supra-renal bodies discovered at the *post mortem* examination of the body.

The patient was a well-developed labouring man, aged about sixty-two, who was admitted into the Norfolk and Norwich Hospital, under my care, on August 31, 1861, suffering from great debility and exhaustion, apparently the result of the long continued discharge of very pale and copious urine. His history was, that for twenty years he had suffered much from thirst, and had been in the habit of drinking large quantities of fluid to satisfy this craving. He had, however, been in fair health until about two years ago, when his general powers began to fail, but he was not compelled to discontinue his employment until about nine months since.

During these nine months, in which he had been more particularly under observation, the quantity of urine discharged had often amounted to fourteen or sixteen pints daily, being always of very low specific purity, and had never contained either sugar or albumen. He had continued gradually to get thinner, weaker, and paler—the paleness being of a peculiar sallow tint, and sometimes amounting to actual duskiness. The thirst had been constant and often urgent, and the skin always dry and harsh. He had never suffered more than a very slight amount of pain in the back, and his feelings had generally been rather those of weariness and gradually increasing weakness, than of actual pain. His bowels were frequently much constipated, and when this was so, the stomach invariably rejected his food.

For a time he derived considerable benefit from a prolonged course of tincture of steel, but for the two or three weeks prior

to admission, the stomach had been excessively irritable, and he had suffered much from frequent vomiting, and its continued inability to retain its contents. This symptom had been somewhat relieved by the use of hydrocyanic acid and effervescing soda draughts, but had not quite ceased.

The day after his admission to the hospital, his bladder became unable to expel its contents, and from this time until his death, the catheter required to be used daily. The quantity of urine withdrawn was never less than from four to six pints in each twenty-four hours, and it was always pale, clear, acid, of specific gravity about 1005. He now became rapidly typhoid, the tongue and lips dry and brown, the pulse weak and failing, the stomach rejected nearly all nourishment, the complexion assumed a remarkably dirty yellow hue, and he died on September 8th.

Sectio Cadaveris, thirty hours after death.—Body somewhat emaciated; skin with a pale yellow, or sallow tinge.

Chest.—Lungs and heart healthy, but the latter organ rather large.

Abdomen.—Liver congested, especially in its centre, where it was soft in texture, and filled with black blood, almost to a state of parenchymatous apoplexy.

Spleen small, and bloodless, but healthy looking.

Kidneys.—Both organs diminished in size, deeply lobed on the surface, and very dense to the feel in the position of the cones. On section they were seen to be greatly wasted. The cortical portions very thin, and scarcely to be distinguished from the pyramidal. The cones were nearly absent, or rather were converted into dense fibrous tissues, containing many large cystiform spaces. The mucous membrane of the pelvis was thickened, fibrous-looking, and darkly congested. The pelvic cavities considerably enlarged. The right was, on the whole, rather more diseased than the left. Ureters a little dilated.

Bladder considerably enlarged. Its walls thin and pale, some blood effused under its mucous membrane. The vesical orifice of prostatic urethra large and evidently dilated.

Supra-renal bodies greatly diseased; both converted into flaccid cysts, capable of containing each some half ounce of fluid, with thin walls having a bile-coloured granular appearance. The left slightly larger than the right.

On microscopical examination the cortical portion of the kidneys was found to be firmer than in health. Many of the tubes very narrow, and much wasted, while others were twice the diameter of the healthy uriniferous tubes. The walls of the tubes were firm and thick. The capillary vessels every-

where contained numerous nuclei in their walls, and external to them was a considerable quantity of fibrous material, with very numerous nuclei. The Malpighian bodies were for the most part smaller than in health. The epithelial cells were also smaller, as well as more numerous, than in health, and the tubes appeared to be distended in many places by their accumulation.*

The general outline of this case of diabetes insipidus is not very dissimilar to that of many others which are on record, and especially agrees with some which are related by Dr. Willis. We have the usual sequence of great thirst, an excessive quantity of fluid drunk to gratify this craving, a consequent abundant flow of limpid urine; then, after a varying interval, signs of failure of nervous power, with loss of appetite, irritability of stomach, and a gradually increasing languor, and sense of debility.

The chief symptoms present in three cases, of which I have accurate notes, are shown in the following :—

Table of Cases.

H. L.	H. M.	H. R.
Age ; sixty-five years.	Age ; forty years.	Age ; sixty-two years.
Previous diseases ; jaundice, chronic rheumatism, dental neuralgia, epistaxis.	Sub-acute rheumatism, bleeding piles, hœmoptysis.	Not known.
Urine copious, pale, clear, of low specific gravity, free from sugar or albumen.	The same.	The same.
Micturation frequent.	The same.	The same.
Micturation followed by uneasiness in glans penis.		
Weak pulse.	Pulse weak and slow, and heart's sounds very feeble, and often scarcely audible.	
Marked debility, and increasing feebleness.	Marked feebleness.	Increasing feebleness restlessness, and irritability.
Great thirst, gratified by drinking large quantities of fluid.	The same.	The same.
Slight emaciation.	The same.	The same.
Loss of appetite.	The same.	
Some indigestion.		

* This description of the microscopical appearances of the kidneys was kindly made for me by Dr. Beale, who adds, "That this multiplication of cells within the tubes, probably took place within a short period of death."

Table of Cases—Continued.

H. L.	H. M.	H. R.
Recurring diarrhœa.	The same.	No diarrhœa, but frequently constipation, and then always vomiting of food.
Pallor, a peculiar whiteness of complexion.	Pale and pasty complexion.	Pallor, becoming sallowness towards the close; skin dry and harsh.
Slight pain over sacrum, and in iliac regions.	Vague pains in the abdomen and limbs.	Slight pain in the back.
In latter period of life, very troublesome sickness.		The same.
Retention of urine preceding death.		The same.
Death by exhaustion.	Still alive.	Death by exhaustion.

The condition of kidney which is so markedly seen in this case (*vide* Plate X, fig. 1), and which is evidently one of inflammatory condensation and atrophy, existed, though in a lesser degree, in the patient whose *post-mortem* appearances are recorded in my former paper on this subject. Indeed, the kidneys altogether may be considered to be in the same pathological condition, although the longer duration of the disorder, and, perhaps, its greater intensity in the one case than in the other, had carried those changes to a greater extent. In both cases, the kidneys, previous to section, showed deep depressions on their surface, tending to divide the organ into separate portions or lobes, whilst the pyramids were very firm and dense, and yielded, when compressed by the fingers, a sensation as of small tumours or nodules. In both, division showed that a gradual destruction of the cortical portion was going on, with a simultaneous deposition of (or conversion of renal tissue into) fibrous tissue; and in both the pelves and ureters were dilated.

It is, perhaps, worthy of passing notice, that in another disease attended with a certain amount of diuresis, viz., chronic desquamative nephritis, there is also a tendency to a wasting and atrophy of the kidney; the organ being in these cases found after death to have suffered a diminution both of bulk and weight. But although this is so, it would, I think, scarcely be either safe or justifiable to draw from this fact any conclusion as to the dependence of the chronic diuresis upon any irritative or inflammatory condition of the kidney; for, on the one hand, we have an equal amount of diuresis in diabetes mellitus, where no such pathological condition is found, and on the other, there is no doubt that such inflammatory atrophy may be due simply

to the overworked and irritated condition in which these glands have so long been kept,—a condition which, though in all probability producing at first nothing more than passive congestion or an attempt at hypertrophy, would inevitably by degrees lead to condensation and degeneration of the excreting structures, even were there an absence of the destructive and sacculating influence upon the kidney which the constantly distended state of the ureters and pelvic cavities must be incessantly exerting.

This atrophied condition of kidney is well described by Rokitansky, who says,—"Chronic inflammation is, like the acute form, frequently followed by atrophy of the kidney, inasmuch as not only its product, but the original tissues themselves become absorbed. This secondary atrophy attacks either the entire kidney or sections of the organ; and the consequence is, accordingly, a uniform reduction of its size, or a partial contraction, which gives the kidney a shrivelled and uneven lobulated surface . . . . . On closer examination, we find the cortical substance (in extreme cases) reduced to a mere vestige; the pyramids are diminished to a size corresponding to the dimensions of the organ; the tissue generally is of a pale-red, or here and there of a slate-gray colour, denser, tough, and fibro-cellular."

If, then, this degenerated condition of kidney, marked and striking as it is, is only a secondary and not the primary disease, we are still as much as ever in want of an explanation of the real nature of the cause in operation to produce the diuresis and its secondary effects upon the kidney. I am not aware that the condition of the supra-renal bodies in this disease has ever been made the subject of observation, but I now wish to call attention to the fact, that, besides the disease of the kidneys, there was, in the case now reported, marked disease of both of these capsules,—a disease which was evidently of long standing, was apparently of a degenerative character, and which had resulted in a great enlargement of these organs, and their conversion into semi-pulpy flaccid cysts. Their natural function was therefore destroyed, and I would venture upon the suggestion of the *possibility* of some irritative disease of the supra-renal bodies being the exciting cause of the disorder known by the various names of Diabetes Insipidus, Hydruria, or Chronic Diuresis.

The great class of cases in which supra-renal disease was found to co-exist with a peculiar deposit of pigment in the skin and other tissues, to which Dr. Addison directed attention, has, (he says), for their leading features, anæmia, general languor, and debility, remarkable feebleness of the heart's action, and irritability of the stomach. In these cases also, we have all the

marked anæmia, increasing languor and debility, irritability of stomach, &c., upon which he laid so much stress, with the addition of diuresis. The dark discolouration of skin is, indeed, absent, but (merely noticing the fact that duskiness of the skin has not been present in all the recorded cases of supra-renal disease), I would observe that there is in its place a very evident alteration of colour, consisting in a loss instead of an addition of pigment, and a *whiteness* of complexion which has struck my eye as having a peculiarity quite distinct from that of chlorotic or ordinarily anæmiated patients. In Dr. Addison's cases, and, indeed, in nearly all those yet recorded, the disease was such as mechanically to interfere with the action of the supra-renal bodies, or to destroy them by acute inflammation. In my case the disease was probably of an irritative or chronically degenerative nature. The office of these organs is quite unknown; they are very largely supplied with blood-vessels and nerves; they are in immediate juxta-position with the kidneys. If they have any power of presiding over and regulating the complicated function of renal secretion (and may not this be a portion, at least, of their uses?), any continued irritation of their structure would be the very thing to induce such an exalted action of the kidney as would lead to an increased production of the peculiar elements which it was its special duty to eliminate, and one of which is undoubtedly water. That in those cases in which marked disease has been found in these organs, no diuresis existed, does not, in my opinion, annihilate this hypothesis, seeing that such disease may have been of an entirely different character from the one under consideration.

If, on further investigation, any connexion should be found to exist, as now suggested, between Diabetes Insipidus and disease of the supra-renal capsules, such a name as *Hydruria suprarenalis* might appropriately express the morbid condition. I am well aware how dangerous it is to attempt to generalize from a single case, or to lay too much stress upon pathological appearances which may prove to be merely coincidences, but in the case of the disease under consideration, I am so satisfied that we have something more to deal with than a mere habit of thirst, or a depraved condition of digestive or pharyngeal mucous membrane, at the same time that we are in such utter ignorance of what the morbid change may be that gives rise to the symptoms, that I feel no hesitation in venturing thus to throw out the suggestions I have now made, in the hope at least that they may lead others to examine into the condition of these much-neglected organs in this disease whenever the somewhat rare opportunity for so doing offers itself.

Part III.

RESULTS OF CHEMICAL AND MICROSCOPICAL EXAMINATION OF VARIOUS SPECIMENS.

LARVÆ OF CERTAIN SPECIES OF BLOWFLY EXPELLED ALIVE FROM THE BOWELS.

Dr. Brinton's Case in which the Larva of *Musca Sarcophaga* was found alive in fæces.

[*Extract from a letter to the Editor.*]

"I LATELY inspected the alvine evacuation of a patient immediately after its expulsion; and, noticing deep in the interstices of two of its triple colic rows of *scybalæ* what seemed to a casual glance an ordinary *oxyurus vermicularis*, I at once secured the specimen for some researches I have long been pursuing on the metamorphoses of this parasite."

"It was not till the next day that I had any further opportunity of examining the specimen, which had meantime been securely placed in a saucer moistened with distilled water, and covered with a bell glass. The moment I laid hold of it with the forceps, its smooth buxom skin, quite unlike the hard chitinous feel of the *oxyurus*, apprized me of my mistake in supposing it to be the creature I was in quest of; and to my amazement, in a few seconds, I was further disillusioned by the little creature lifting its head, and turning it round with that air of bland inquiry and expostulation with which a maggot seems to resent being thrown out of his bed and board to starve in a desolate world."

"The microscope confirms the evidence afforded by the appearance and manners of the creature. You will see that it is the larva of an insect, with branching tracheæ, numerous segments to its body, &c., &c. I only add, that the patient had

had no symptoms whatever referrible to the stomach or bowels, and has not detected any more *larvæ* in his evacuations since; and that the larva, to all appearance in a state of suspended animation when first noticed by me in the scybalous excrement, and recovering its vigour by a few hours exposure to the air, retained signs of life for more than thirty-six hours after its immersion in distilled water."

Its species I dare not decide; but it is evidently one of the *Muscidæ,* and not, I think, the *vomitoria,* but the *sarcophaga,* infesting cheese and bacon, to its involvement in which, it owes its occasional introduction into the human body. Counting the head as four small segments, I make out fourteen in all."

Case by Michael Blood, M.R.C.S. (St. Heliers, Jersey).

Mr. M., aged 39, applied to me eighteen months since, for great uneasiness in the rectum; a creeping, crawling sensation, attended with a sensation of sickness: his general health was good, save some slight gouty spmptoms occasionally. I directed a purge, with an injunction to observe closely the excretion, and he observed several of those nondescripts alive in the fæces; he picked out several and brought them to me in a bottle, they were in various states of development, and not having seen any thing like them before, I showed them to a *confrère* who had a microscope, who could not enlighten me on their kind or origin. I questioned Mr. M. as to the digesta he indulged in, and I found he had a partiality for German sausages, which he ate for breakfast frequently, and I told him I believed he took the cause in his sausage. He relinquished the use of the German sausage, but has had frequent returns of the annoyance. The last specimens I sent were followed by others similar since; purgation and various vermifuge medicines were had recourse to, with occasional cessation of the appearance of these creatures. But still in various shapes, gravamens, &c., they make their appearance; a very guarded diet is now to be adopted, and pork, cheese, and sausages, in every shape, are to be relinquished.

[The bodies alluded to were forwarded to me for examination by my friend Dr. Graily Hewett, and were of the same nature as those described in Dr. Brinton's case. Another example in which they occurred is referred to in the "Microscope in Practical Medicine," second edition, page 7.—*Editor.*]

CAST OF THE ŒSOPHAGUS COMPOSED ENTIRELY OF EPITHELIUM.

Forwarded for examination by S. Wood, Esq. (Shrewsbury).

The following is an extract from Mr. Wood's note:—"I feel induced to trouble you with the enclosed, although I know so little about it. It was given to me by a medical friend in Shrewsbury; all I know is, that a lady patient of his was for a long time troubled with sickness, which nothing would allay, and was reduced to extremities, when she vomited several pieces like the enclosed, but much longer, three inches in length. They appear membranous, but are not, I believe, of a vegetable nature; on being burned, they give out the peculiar smell of animal tissue. I have never seen anything like this; the thicker portion feels like the membrane of diptherite, but the thin, firm membrane is very peculiar. Is it an exudation from the œsophagus? I have just received another portion, seven inches long, which appears to be a cast of the œsophagus, and when fresh, was of a light skin colour."

Upon microscopical examination, it was found that Mr. Wood's conclusion, as to the nature of these membranous masses was quite correct; they were composed of the firm and closely matted layers of squamous epithelium, which forms the lining of the œsophagus; several of the masses formed complete tubes. The case is especially interesting, as demonstrating the fact that a considerable thickness of an epithelial layer may be removed from many surfaces. Cases are recorded in the "Archives," in which large plates were removed from the mucous membrane of the stomach, small intestines, uterus, and vagina, and below an example of the same change, affecting the epithelial coat of the large bowel of a child, is given.—[L.S.B.]

CASTS CONSISTING OF FLAKES OF EPITHELIUM AND MUCUS PASSED IN THE STOOL BY A CHILD AGED FOUR YEARS.

Sent for examination by James Borrett, M.D. (Sherborne).

The masses were tolerably firm, and some of them were evidently portions of a tube. They were passed by a child, aged four, without giving rise to any urgent symptoms. On microscopical examination, the tissue was found to be composed of a very firm mucus, in which numerous cells of epithelium from the large intestines, were imbedded. The following notes of the case are extracted from Dr. Borrett's note.

"The casts of mucus and epithelium were passed by a little girl after some weeks of pain in the body. My fears were that some foreign body had been swallowed; a button having

once been passed up the nostril, and not recovered. We always had a difficulty in getting the little girl to sit down, and relief of bowels always caused more or less pain."

"The substance came away after a strong dose of senna tea, which produced great griping; it had been found that senna always caused distress, and castor oil was the aperient used afterwards. There was increased sensibility of the canal, which made senna a bad aperient."

"The mucus and epithelium cast of bowels was passed in February, 1860; since which time, the child has enjoyed good health; she never makes any complaint of pain in the bowels; the appetite is large, and the general condition of the child excellent."

DIPTHERIA IN THE PIG.

Some time since, my friend, Mr. McCormick, of Aylesbury, sent me for examination, the tongue and part of the pharynx of a pig, covered with a very thick, false membrane. The layer, on the posterior part of the tongue, was of a finer consistence, and about the eight of an inch in thickness. It consisted of a firm material, which was fibrillated, numerous small granular cells, about the size of white blood corpuscles, and epithelial cells, of various ages. From its deep surface, small funnel-shaped processes projected to the distance of a quarter of an inch into the follicles in the mucous membrane, at the lower part of which the multiplication of the granular corpuscles was taking place, apparently with great rapidity. It is probable that had the animal lived, the condition above described, would have soon given place to the process of suppuration, in which case, the mucous membrane in its entire thickness, must have been destroyed.—[L.S.B.]

CASTS OF THE SEMINAL TUBULES.

I have sketched very roughly in plate XIII, of the "Illustrations of Urinary Deposits," the character of some casts, which I believed had been formed in the seminal tubules. I have since seen several specimens of the same character, and in some a few spermatozoa were entangled; but a few days ago, very perfect casts of this kind were found in the urine of an old man, nearly 70 years of age. Amongst the long transparent casts, were others containing numerous spermatozoa. As to the origin of these latter, therefore, there can be no doubt whatever. In Plate X, fig. 4, I have represented one of these casts, containing spermatozoa, and some of the transparent mucous-like casts which, I believe, have also been formed in the seminal tubules.—[L.S.B.]

Part IV.

INSTRUMENTS AND APPARATUS OF PRACTICAL VALUE IN CARRYING OUT SCIENTIFIC INQUIRIES BEARING UPON MEDICINE.

COMPRESSORIUM FOR PRESSING DOWN THE THIN GLASS COVER WHILE CEMENTS OR CANADA BALSAM ARE DRYING.

By F. P. Hoblyn, F.R.C.S., Bath.

And improved by Dr. Falconer, of Bath.

Plate X, Fig. 4.

THE body is composed of a framework of mahogany, 12 inches in length, 3 in width, and 3 inches in height. (Plate XI, fig. 6.)

Nine mahogany fingers, 6 inches in length, are seen passing through holes in the top of the framework, and through corresponding holes in a thin support, to give steadiness to the fingers, so that they may move up and down without any lateral motion.

A round elastic passes through holes made very smooth in the upper part of the fingers, and through small brass eyes attached to the upper surface. This is fastened at the side. The elastic, with hardly any friction, acts as an efficient spring on the fingers; and, by the two hooks, it may be tightened or slackened at pleasure. This part of the arrangement, by which the power of the spring can be altered, was the suggestion of Dr. Falconer.

The apparatus may be French-polished; but it must be borne in mind that the polish will adhere to any slides which may be put on hot; a thin piece of wood, or an extra slide should therefore be placed underneath.

Both sides of the apparatus are of course open, and there is sufficient room for nine slides to be pressed at the same time.

ON DEMONSTRATING MICROSCOPICAL SPECIMENS TO LARGE CLASSES OF STUDENTS.

By Lionel S. Beale, M.B., F.R.S., F.R.C.P.,

Professor of Physiology in King's College, London. Physician to the Hospital, &c.

In the present day, every one who is following out any special line of investigation desires not only to add to the existing knowledge, but feels a wish to place the means of demonstrating the phenomena he has observed at the disposal of others. Facilities for demonstrating facts at present known are scarcely second in importance to original investigation. Teachers of minute anatomy labour under great disadvantage in not being able to demonstrate to their class the various structures they describe. A good preparation well shown will teach a student more, and, at the same time, give him more accurate views of the nature of the structure than the most carefully drawn diagrams, or the most graphic description. In various branches of medicine demonstrative teaching is of the utmost importance; and it seems to me that when actual specimens are appealed to during an oral lecture, and at the same time reference is made to well-executed plans of structure and drawings from nature, the difficulties of learning minute details are, in great part, removed. Real facts are imparted to the student, and he gains ideas of objects from the objects themselves; so that he is less likely to have to unlearn what he has already acquired.

For many years past I have tried various plans for demonstrating microscopical specimens to large classes of students, but, until quite recently, without success.

At the College of Surgeons, as is well known, a theatre has been expressly fitted up for demonstrating microscopical specimens. The plan adopted by Professor Quekett was to arrange a continuous flat surface, on which the microscopes, placed on stands provided with rollers, could be easily moved onwards. By having two rows thus arranged, more than fifty persons could see the specimens. It need hardly be said, that such an arrangement, however efficient it might be, was far too costly for general adoption. Although the movement was very smooth, the vibration while the microscopes were being moved was too great to permit of very high powers being employed;

and in order to show several specimens to many persons within an hour, it was necessary to be provided with several large, and, of course, very expensive instruments.

It was not possible for me to adopt such a plan as this; and I have tried a variety of expedients for effecting the same object in a more simple and less costly manner. The one I am about to describe has been fairly tried in several different classes, varying in number from 20 to 130, during the past twelvemonth. It has succeeded so well, that I feel sure it is suitable for general adoption, not only for scientific, but for elementary popular teaching, even in village schools. It is also inexpensive, and the arrangement is so simple that it cannot easily get out of order. The microscope used is the clinical pocket microscope described in page 289, Vol. II, and figured in Plate XVI. It is also described in the "Transactions of the Microscopical Society," Vol. IX, page 3. This instrument is placed in a small wooden stand, as shown in fig. 10, page 215 of the "Archives," Vol. II. To this an oil lamp is adapted, but the stand may be used by daylight in a room with a skylight by substituting a mirror for the lamp. I am in the habit of employing the instrument in this manner in my clinical demonstrations. It is unnecessary for me to describe the stand, which is of wood, as the drawing referred to above renders any detailed description unnecessary.

In Plate XI, fig. 5, is shown an arrangement, by which a diaphragm, condenser, mirror, polarizing apparatus, and other instruments, can be adapted to the pocket microscope. The different parts will be found fully described in the "explanation of the plates." The round stem on which these are made to slide, screws into the lower part of the stage by a screw almost as wide as the tube, and it may be firmly fixed in its place by a side screw, which presses on the neck just above the thread of the screw.

In fig. 3 is seen a very simple arrangement, by which four instruments are firmly fixed in a stand, which may be placed in front of a window so that direct light may be obtained, or lamps may be placed behind each specimen, or at the side when reflected light is required. The box in which these instruments are placed, is enclosed, above and at the back, by glass, so that the preparations cannot possibly be disarranged by any one. Any alteration in the focus is readily obtained by drawing the tube, in which the eye-piece is placed, up and down as before described. Specimens may be arranged thus and left for examination for hours, without any alteration whatever being made in their position.

Fig. 1 represents a modification of this arrangement, which I have found very useful for demonstrating delicate specimens to a large number of persons. Eight preparations arranged thus take up a very small space, and every one can walk round the apparatus, examining one specimen after the other. The lamp being placed in the centre, illuminates all the preparations. An ordinary French moderator lamp gives a good light, and it may be wound up from time to time by a long key. The entire apparatus is about sixteen inches high and 15 wide in its widest part. The arrangements for fixing the instruments are seen at a glance in fig. 2, and the position of the lamp is also shown. The description of each specimen is written on ground glasses, inserted in the cover, and these are lighted by the same central light.

The stage of the clinical microscope is a very convenient form for photographic purposes, and by adapting the tube to an ordinary camera a very simple arrangement for photographing microscopical preparations is readily made.

All the plans of demonstration I have described, are comparatively very inexpensive, and are adapted as well for popular demonstration, as for higher educational purposes. The focus is easily obtained, and with very little practice a person who had never had a microscope in his hands before, could arrange a preparation in one of these instruments, for demonstrating to a class. I believe that as this plan comes into more general use, each instrument, with its stand, will be made complete with powers, for about three pounds.

I am anxious that the objects I have had in view in arranging these instruments should not be misunderstood. They are not intended for microscope *work* generally, but merely for demonstrating objects to a number of persons. The instrument alone will be found useful as a pocket microscope for field work, but for preparing specimens and for general microscopical observation, the instrument is by no means convenient. Mr. Highley has lately made an arrangement by which the tube of an ordinary microscope may be detached and used as a pocket instrument; but, as a general rule, it will be found convenient to be provided with one of these instruments as well as an ordinary microscope. The apparatus I have described may now be obtained of Mr. Highley, 70, Dean-street; of Mr. Matthews, Portugal-street, Lincoln's-inn; and of other microscope makers.

Part V.

REPORTS OF RESEARCHES PUBLISHED ELSEWHERE.

REPORT ON MUSCULAR CONTRACTION,

By A. B. Duffin, M.D.
Assistant Physician to King's College, Hospital.

(abstract.)

UEBER DIREKTE UND INDIREKTE MUSKELREIZUNG MITTELST CHEMISCHER AGENTIEN. Von D. W. KUHNE. Müller's Archiv, 1859, p. 213.

UEBER MUSKELZUCKUNGEN OHNE BETHEILIGUNG DER NERVEN. *Ibid.* p. 314.

UEBER SOGENANNTE IDIOMUSKULARE CONTRACTION. *Ibid.* p. 418.

UNTERSUCHUNGEN UEBER BEWEGUNGEN UND VERANDERUNGEN DER CONTRACTILEN SUBSTANZEN. *Ibid.* pp. 564 and 748.

UEBER DIE CHEMISCHE REIZUNG DER MUSKELN UND NERVEN UND IHRE BEDEUTUNG FUR DIE IRRITABILITATSFRAGE. Muller's Archiv, 1860, p. 315.

UEBER DIE WIRKUNG DES AMERIKANISCHEN PFEILGIFTES. *Ibid.* p. 477.

FOR some years past the question of muscular irritability has been attracting an unusual share of attention among German physiologists. Indeed, since Bernard, in 1844, instituted his first experiments with the Woorari poison the discussion has been carried on with great intelligence and zeal. No one, perhaps, has contributed more facts, or has reasoned out the entire question more carefully than Dr. Kühne, of whose experiments and arguments we propose to give a brief abstract, confirming and contrasting them, as we proceed, from the observations of others of his countrymen, who have been simultaneously engaged in the same field. Although each paper is to a great extent independent, and it is obvious that, when writing the earliest of the series, the author scarcely anticipated the direction which his researches might ultimately take, we prefer analyzing them as a whole, selecting from each as occasion may require, inasmuch as one broad and definite idea evidently underlies the whole series,—that of establishing the intrinsic value of Haller's doctrine of muscular irritability.

We will then start with a statement of the author's observations on the mutual anatomical arrangement of muscle and

nerve. He thus describes it in the sartorius of the frog, the muscular and connective tissues of which he previously renders transparent by soaking it for twenty-four hours in hydrochloric acid of the strength of 0·1 per cent. The main nerve-trunk reaches the muscle at right angles to the direction of its fibres and at the lower portion of its middle third. It immediately divides into two branches, which tend to the opposite ends of the muscle. These primary branches divide and subdivide dichotomously, usually sending off a few recurrent twigs at each bifurcation. Microscopically, the primitive nerve-fibres will be found to subdivide. They run parallel to and between the muscular fasciculi, each breaking up into secondary tubes by bifurcation, often with the formation of distinct tertiary tubes by the splitting of the secondary ones. At a certain point, however, the nerve-tube will be observed totally to disappear. Occasionally a secondary fibre may at this point be seen apparently to unite with a muscular fasciculus, a slight nodular swelling indicating the point of junction. In the frog, however, Kühne was quite unable to trace the nerve through the sarcolemma. There are districts in every muscle in which the most careful examination fails to detect any trace of nerve. The upper wide end of the sartorius of the frog is entirely devoid of them in its terminal 2-5 millimetres, and none are to be detected in the lowest 1-3 millimetres of the muscle. Even in vertebrate animals it was possible to prove that the nerves were throughout provided with white substance. This never disappears, but the double contours are lost simultaneously. Meissner* was one of the earliest observers to trace the nervous structure beyond the sarcolemma. He describes the primitive fibres as being $\frac{1}{800}'''$ in diameter. They invariably run parallel to the muscular primitive fasciculi, but neither on the fibres nor on the primitive nerve-trunks could a neurilemma be distinguished. When the primitive nerve-fibre reaches the edge of a muscular fasciculus he states that it widens considerably, becomes triangular, and that its base so adheres to the margin of the muscle as to constitute a perfect union of these parts. Similar observations were made by Munk.† Kühne examined the muscles of the thigh of hydrophilus piceus and of oryctes nasicorins by means of polarized light, as proposed by Brücke, and in them he observed the nerves to pierce the sarcolemma, becoming simultaneously divested of their sheaths.

Our readers may recollect that Leydig‡ described a system

* Zeitschrift f., W. Zoologie, B. V. Anatomie und Physiol.. v. Mermis Albicans.

† Göttinger Nachrichten, J. 58.

‡ Lehrbuch d. Histologie, p. 135.

of cavities in muscle, under which he included all the so-called nuclei of muscle. Kölliker* considers all these to be real nuclei, but regards himself as the discoverer of true vacuoles, filled with a finely granular mass.† Kühne has seen large vesicular nuclei, fine linearly-disposed granules and vacuoles of various sizes devoid of granules. These last are usually spindle-shaped, and are sometimes seen to be united in groups of two and three by a canal. Slight pressure causes them all to vanish. Their red aspect separates them from the nuclei. The rows of fine granules are also to be found in every muscle in its entire length. Every primitive fasciculus in hydrophilus and oryctes, so long as it is irritable, shows one or more very regular tracts of large granules. One streak appears to run along the axis, and other two at the border, close under the sarcolemma, these occasionally anastomosing to constitute a fourth streak. They are distinguished by their finely granular or dusty aspect. These organs are in intimate relation with the nerve-fibres that break through the sarcolemma. Whenever the nerve pierces the sarcolemma it is where such a row of large granules courses along it. Only a short blunt extremity of the axis-cylinder is visible, and this appears to become granular and to identify itself with the substance lying between the large granules. Thus the rows of granules in the muscles of insects are but the extension of the true intra-muscular axis-cylinder of the motor nerve-fibres. The termination of this arrangement consists in the gradual dwindling away of the rows of granules till the eye can no longer discriminate between the ultimate ends and the contractile substance which is regularly traversed by the disdiaclasts.

Beale has shown that, of the oval nuclei seen in connection with the elementary muscular fibres of vertebrate animals, some belong to the capillaries, some to the nerves, and others are the nuclei of development of the contractile tissue. The last are always arranged longitudinally. The nuclei of the capillaries and nerves pass in different directions, *longitudinally*, *transversely*, and *obliquely*, always *on the surface of the fibre*. Beale describes every fibre as abundantly supplied with nerves, and states that the oval nuclei are the organs through which the nerve acts on the muscle. The nerves form a network on the surface of each fibre; and he has seen this in preparations of the mouse and other mammalia, in which the capillaries *had* been injected with Prussian blue fluid. No white substance or tubular membrane can be detected; but the delicate fibre can be seen in the intervals, between the nuclei, having a pale

* Gewebelehre, p. 180. † *Ibid.*, p. 174.

granular appearance in the preparations which have been preserved.* Beale believes that the granules and nuclei, which have been considered by some authors as elongated spaces, seen amongst the fibrillæ (especially in the frog), exactly correspond to the so-called nuclear fibres in tendon, and really consist of nuclei (masses of germinal matter) and imperfectly formed fibrillæ which are undergoing development.

Struck by the scantiness of our knowledge of the effects of different chemical substances as excitors of muscular action, according as they were applied to the motor nerve or to the muscular section respectively, Kühne instituted an elaborate series of experiments, in order to ascertain if, from the nature of the excitant, it were possible to demonstrate that the sarcous tissue were capable of direct excitation, *i.e.*, irrespectively of its motor nerve.

In all his experiments, unless it be expressly stated to the contrary, he employed the sartorius of the frog, which, from the length and great parallelism of its fibres, and from its nervous distribution, he considers to be peculiarly adapted for experiment. The following are the results which he obtained:—*Action of Acids.* Hydrochloric acid, if applied to the nerve trunk, required to be of a strength of 19–20 per cent. to induce contraction. On the other hand, an acid of the strength of 5, or even of 1 per mille, applied to the section of the sartorius, sufficed to induce contractions as active as those of the strong acid when applied to the nerve. Nitric acid only acted through the nerve when of a strength above 15 per cent., but a solution of 5 per mille applied to the muscular section proved abundantly efficient. Sulphuric acid he avoided, as it is impossible to discriminate its immediate effects from the results of thermic irritation. All these acids he presumes to affect the arcous substance by dissolving the syntonin, and not simply by altering the reaction of the section. Chromic acid applied to the nerve required to have a percentage of 5 parts to induce contraction, whereas a dilution of 5 per mille acted powerfully on the muscular section. Concentrated acetic acid, with equal parts of water, acted when applied to the nerve, whilst an acid of 6 per cent. dilution distinctly affected the muscular section. The same held of phosphoric acid.

Action of Alkalis.—The contrast of the direct and mediate effects of these bodies was far less decided than in the case of the acids. Thus of caustic potash Kühne says that a dilution of ·8 per cent. constantly caused contraction when applied to the nerve, and that even ·1 per cent. was not unfrequently

* Phil. Trans. Royal Society, 1860.

efficient, whereas, when applied to the muscular section, ·2 or even ·3 per cent. gave very uncertain results. Caustic soda acted similarly. If an entire sartorius were dipped into a solution of ·1 per cent., it contracted tetanically, and at once lost all irritability, even to the strongest streams of the Du Bois Regmond's induction apparatus. The action of ammonia proved to be very remarkable. As soon as its vapour became perceptible to the smell, the muscle began to contract, and as the rod is approached to the section a true tetanus ensued. The sensibility was so extreme that the minimum percentage of the solution could not be determined. If the muscle, however, were so sealed away that the nerve only could be exposed to the vapour or to the solution, no contraction whatever followed, however strong were the solution employed. The nerve can be exposed alone by drawing it through a hole in a piece of glass, and fastening it in with fat. He also employed lime solution, but of what strength the atmospheric air prevented him from determining. The nerve soon lost its irritability, whilst the muscular section long retained it. *Metallic salts.*—1. Sulphate of copper. Neither saturated, nor any other solution caused contraction when applied to the nerve, but all forms of concentration down to 4 per cent. caused violent contraction when applied to the muscular section. 2. Sulphate of iron had just the same effect on the nerve as the former. A solution containing 2–3 per cent. of the salt acted on the muscular section. 3. Sesquichloride of iron acted through the nerve if of a strength of 20–30 per cent., whereas a dilution of 1 per cent. acted amply on the muscular section. 4. Sulphate of zinc proved an excitant for the nerve down to 20 per cent., but to the muscle down to 1 per cent. 5. Chloride of zinc acted more forcibly through the nerve than any other metallic salt. Applied in a syrupy condition it scarcely affected the muscle, although if diluted it acted strongly, even 1 per cent. solutions were quite efficient. 6. The neutral acetate of lead in saturated solution only occasionally acted through the nerve. The minimum point for the muscular section was 4 per cent. 7. The basic acetate when of a strength above 10 per cent. acted through the nerve, but a strength of 2 per cent. sufficed to excite the muscular section. 8. Nitrate of mercury acted on both nerve and muscle. 9. The bichloride of mercury never excited the muscle indirectly, and its direct effects were somewhat irregular. 10. Nitrate of silver acted through the nerve. 11. Chloride of sodium is an active excitor both directly and indirectly, but it must be rather more concentrated for the latter. 12. Chloride of calcium only affected the nerve when

in strong solution, but the application of a fifty-fold dilution to the muscular section induced contraction.

Organic acids.—1. The action of oxalic acid was very uncertain. 2. Acetic acid must be concentrated to act through the nerve, whereas its vapour abundantly affected the muscular section. 3. When the end of the nerve was dipped into syrupy lactic acid, spasm at once set in, but when the muscular section was touched with the same, no result ensued, and it was only when the muscle was buried in the acid that it gradually drew itself together for a final rigor. Here, then, the usual conditions were reversed. But if the acid were diluted with equal parts of water, it ceased to work on the nerve, but acted with great power on the muscular section. Creosote and carbolic acid acted powerfully on the nerve, and but slightly on the muscular section. Concentrated alcohol also acted on the nerve, although in no degree of concentration did it affect the muscular section. Ether and chloroform applied to the nerve scarcely ever caused contractions, but the approach of an open bottle of the former to the muscular section induced gradual and permanent rigidity. If the muscle were left in a space saturated with the steam of warm water, it gradually recovered its irritability. Chloroform rapidly applied to the muscular section caused spasm. If the cut end of the nerve be dipped into pure glycerine, in a few seconds feeble fibrillar contractions are observed in the gastro-cnemius. These extend in the breadth of the muscle, until at last the entire limb passes into a tetanic state as complete as that produced by strychnia. But if the transverse section of a sartorius be dipped into glycerine, no spasm will result. If the muscle, however, be dipped into a dilution with 5 parts of water, it will contract every time a fresh section touches the fluid. If diluted with more than 2 parts of water, glycerine ceases to act on the nerve. Thus, the limits of its direct and indirect exciting powers are strictly defined. The earlier experiments with bile were very contradictory, but ultimately the following facts were elicited. Bile has a real exciting influence on both muscle and nerve. Many specimens of bile are not sufficiently concentrated to excite through the nerve trunk, but a little evaporation will render them efficient. Every specimen is sufficiently concentrated to excite from the muscular section. Even a dead and putrefying muscle if dipped into certain specimens of bile will undergo a peculiar steady kind of rigor, which must of course not be confounded with a true contraction. The biliary alkaloids have a similar action to the bile itself. A solution of 1 or 2 per cent. will affect the muscular section, but 6 per cent. of the salt is required to influence the motor nerve.

Conclusions.—As a rule, the muscle is more irritable than the nerve. The re-agents employed may be thus subdivided: 1. Those that affect the muscular section in a dilution greatly inferior to that in which they affect the nerve; of these hyhrochloric and nitric acids may be taken as types. 2. Those that act on muscle in a concentration in which they no longer influence the nerve, as chloride of sodium, chloride of calcium, acetic acid, lactic acid, glycerine and the biliary alkaloids; 3. Potash and soda affect the muscle and nerve about equally. A 4th class act violently on the muscle, and not at all on the nerve, as sulphate of copper, and particularly ammonia. A 5th series will excite through the nerve but scarcely by direct contact with the muscle, as creosote, alcohol, concentrated glycerine, syrupy lactic acid. A last class may be said not to affect either organ sensibly, as the fatty oils, and turpentine.

In perusing the results of this series of experiments one broad question starts to the mind. When we directly irritate the muscle by means of chemical re-agents, do we affect the contractile substance, or only the intermuscular nervous twigs? To determine this point, Ludwig demands that we should either succeed in obtaining contraction from a muscle which is destitute of nerves, or whose nerves have been functionally annihilated to their extreme ends.* This postulate was a few years ago believed to have found its answer in the researches of Bernard and Kölliker, into the action of Woorari poison; the former concluding that its effects were manifested on the peripheral motor nerve system,† the latter that urari poisons the motor nerves of the voluntary muscles through the blood, and in frogs destroys the muscular nerve termination in a few minutes."‡ To these statements, however, Schiff§ raised the serious objection, that all the observed phenomena could be explained by presuming those portions of nerve which are endowed with white substance to be alone affected. Funke also urged some difficulties in the way of the reception of Kölliker and Bernard's theory. (Beiträge zur Kenntniss d. Wirkung des Urari, etc. Verhand d., K. Sächs, Gesellchaft, 1859.) But its most decided antagonist proved to be Eckhard, who argued that inasmuch as the poison particularly affected the nervous system, it attacked the ganglia of the heart, and weakened the force of the heart's stroke, so as to retard the circulation in the muscles, and thus rendered it impossible for perfect paralysis of the ends of

* Physiol., 1 Aufl., Bd. I., p. 355.
† Leçons sur les effets des Substances Toxiques et Medicamenteuses.
‡ Virchow's Archiv. B.X., p. 71.
§ Physiol. Muskel Reizbarkeit, p. 19–20.

the motor nerves to occur within them; thus, the contractions obtained after Urari poisoning were to be referred to some residue of nerve force still left in the muscle.* He further argued, that when the motor nerves were paralysed to their physiological extremities, the muscle was quite incapable of responding to any stimulus whatever. The question can only be cleared up by a careful study of the effects of direct irritation on muscles poisoned with curari, and the objections would certainly lose force if any essential deviation from the standard could be noted in the form or character of the contractions. The idea that muscular irritability was actually increased in this form of poisoning was disproved by the following experiment by Rosenthal.† Two thighs being prepared according to Du Bois' method, so as to poison the gastro-cnemius of the one but not of the other, these muscles were so arranged as to be exposed to perfectly equal induction streams. The secondary spiral was then approached, and as the irritation increased contraction invariably began earlier in the unpoisoned than in the poisoned muscle. Kölliker, however, believes that in Urari poisoning the muscles evince a greater disposition to purely local‡ contractions.§ Haber also says, that "the muscles when brought into immediate contact with curari do not lose their capacity of responding to direct excitation, but the contractions are limited to those fasciculi to which the irritation is directly applied" (Müller's Archiv., 1859, p. 115). Kühne objects that the muscle employed by Kölliker (the Reichert's skin muscle of the frog) was not adapted to solve the point at issue, as it is impossible to procure it without injuring some of its longitudinal fibres. He also objects to the electrical test as employed by Kölliker, that in addition to the streams of greater density between the two electrodes, stream curves of lesser density traverse the whole muscle, so that a muscle in appearance only locally irritated may be excited throughout its whole extent. Employing the sartorius of the frog, he repeated these experiments, the electrodes being so arranged as only to expose a minute piece of the muscle to the stream, and the coils being very gradually approached, so that the secondary currents should be too feeble to be capable of any disturbing influence. He then observed that the portion of muscle which lay between

* Beiträge zur Anatomie, vol. I., p. 47.

† Uber die relative Stärke di direkten u indirekten Muskelreizung. Moleschott's Untersuchungen, vol. 3, 1857.

‡ The word local is used by Kölliker to signify either the contraction of a few fasciculi in the long axis of the muscle, or a contraction of a portion of the length of a fasciculus only. He here applies the term in the latter acceptation.

§ Op. cit. p. 133.

the plates never began to contract alone; but that as soon as the secondary spiral acquired a determinate relation to the primary coil, the whole muscle invariably contracted in its entire length. Had Kölliker's statement been correct, only the portion included between the electrodes should have contracted. Kühne then submitted muscles poisoned with curari to the series of chemical tests above referred to, with these results. Bodies that do not act on the healthy muscle are also inactive on the poisoned one. Solutions so dilute as just to cause twitching in the healthy muscle also excite the poisoned one. In short, all that has been said of direct muscular irritation holds, without exception, of the muscles of frogs poisoned with curari. Now no experiment is more adapted to bring forth Kölliker's local spasm than chemical irritation, yet it was never observed. The inference is, that the action of curari alone is incapable of deciding the question of muscular irritability. We shall subsequently return to the estimate of the actual value of curari.

We have just heard Eckhard talk of paralysis of the ultimate ends of motor nerves. The method by which he believed himself to have attained this desideratum was by the application of a constant electrical stream along the track of the motor nerve, the direction of the stream being from the muscle towards the nerve centres. Thus the positive pole was situated between the muscle and the negative pole. The nerve being exposed to this ascending current, he then tested the muscle itself with a second electrical apparatus, and ceased to obtain any contraction from its application. They at once re-appear when the paralysing chain is opened.* Pflüger deduces the law, "every constant stream which flows through any portion of a motor nerve diminishes the irritability of the same at all points on the side of the positive electrode, consequently if the stream ascend, the nerve will be less irritable than before, even to its extreme ends."† Now Kühne most reasonably objects to the employment of electricity as a direct muscular test when the nerve is thus exposed, and he urges the advantage to be derived from the use of chemical excitants. Still employing the sartorius and its nerve, he exposes the latter in a small gutta percha conduit to the action of the constant stream, allowing the muscle to hang free by its lower tendinous end. Every precaution being then taken to prevent dragging or desiccation of the parts, the muscle is tested by a direct electrical stimulus. The constant ascending stream is next opened on the nerve, and the muscle is thus brought to rest.

* Eckhard. Op. cit., p. 48. † Pflüger, Physiologie, d. Elektrotonus.

It will then be found requisite to advance the secondary spiral of the induction apparatus, which is being used as the medium for direct excitation, considerably, in order to cause the muscle to re-act. Similar results will ensue if a Grove's cell and Rheochord apparatus be employed as the measure of the intensity of the direct stimulation applied to the muscle. Moreover, the application of a metallic rod, or touching the muscular section with a non-exciting fluid, will not cause the slightest reaction. We are now in a position to apply chemical excitants to the muscle, whilst its nerve is thus paralyzed. If a vessel with dilute hydrochloric or nitric acid be approached to the muscular section, a single forcible contraction will ensue in the entire length of the fibres. A dilution of $\frac{1}{1000}$ of hydrochloric acid acted as strongly as in the series of experiments already detailed. The same holds of nitric acid. The actions of potash and soda were found identical with those already observed, and tetanus could be induced three or four consecutive times by the employment of the remarkable agent ammonia.

The results of experiments with chloride of sodium, sulphate of copper, chloride of calcium, dilute glycerine, etc., fully confirmed what has been already advanced. Thus the objection of Eckhard, that the loss of irritability by the ascending constant stream is not confined to the nerve, but passes into the muscle, is fully met. The muscle responds most decidedly to its appropriate stimuli when its nerve is in the state of anelectrotone. Eckhard has, however, objected to the use of chemical irritation at all. But Pflüger* shows that if a nerve be excited by such a substance as chloride of sodium, and the constant ascending stream be then applied, the tetanus induced by the chloride of sodium will be at once arrested. This experiment not only brings chemical and electrical tests into harmony, but demonstrates that the ascending stream paralyses the nerve at every point to which chemical irritation can be applied. Kühne, indeed, has shown that this law is applicable to the ultimate primitive fibres. In order that the ascending stream may neutralize a contraction, resulting from irritation of that mixture of muscle and nerve which is afforded by an ordinary section, it is necessary that the direct excitant employed should be capable of affecting one factor only of the combination, *i.e.*, the nerve. Such a substance he finds in concentrated glycerine, which we have seen to cause the most violent tetanus when applied to the nerve, but when applied to a section close to either extremity of the sartorius, to remain inoperative. If, however, a section be made nearer to the point of entrance of

* Physiologie, d. Elektrotonus.

the nerve, 5–6 millimetres from the end of the muscle, and the glycerine be then applied, after a time contractions will ensue. These are due to excitation of the intramuscular nerve, without any direct participation of the contractile substance. The proof lies in this. If the nerve of a sartorius be exposed as before, and a muscular section in the situation indicated be dipped into concentrated glycerine, contractions, at first fibrillar and very unlike those caused by true muscular irritants, will ensue. Let the ascending stream for the nerve now be closed; the muscle is at once tranquillized. If the circuit be again opened, the usual opening's contraction occurs, and at once passes into the glycerine contractions, which soon reach a perfect tetanus. Each of the other chemical excitants corresponds in its effects with what has been already advanced, no matter how varied the combination of muscle and nerve in the surface tested. Those sections which are near the nerve-trunk, further prove that the paralyzing influence of the constant stream at no point passes into the muscular tissue, and conversely, the distant sections show that the influence of the ascending stream reaches to the ultimate nerve fibrillæ. Thus the ascending stream is powerless over the irritability of the sarcous tissue, but renders the motor nerve insensible to its extreme ends. It is also hereby proved that the muscle propagates the excitation from transverse section to transverse section by its own substance, and without the agency of the nerves.

Many questions of moment are directly allied to these considerations. They afford data towards the determination of the ultimate distribution of nerve to muscle. The question of the retrograde or double sense conducting power of nerve tissue is also fairly opened. The varieties of muscular contraction admit of discussion, and the exact effects of Curari on muscle and nerve can be analysed. With all of these subjects Kühne has dealt more or less extensively. We will review them in the order here stated.

Rosenthal * ascertains that the motor nerve is more easily excited by slight oscillations than the muscle by direct electrical excitation. Hence a muscle with many intramuscular nerves will be more easily excited than one with few, and those parts of the muscle which are rich in nerves will more readily be induced to contract than those which are scantily supplied. The diminished irritability of the two terminal segments Kühne observes to be in remarkable harmony with the anatomical absence of nerves in these parts upon which he has already insisted. But can these phenomena be referred to the descending

* Op. cit.

curve of irritability of the motor nerve from centre to periphery? Were this the case the irritability of the muscle should gradually diminish in the form of this curve from the hilum to the extremities. Now careful observation with the Rheochord as a measure indicates a point of maximum irritability close to the hilum. In the immediate neighbourhood there is certainly a diminution, but then the intensity of current required remains pretty constant till near the termination of the muscle, so as not to represent a curve. When close upon the extremity the Rheochord suddenly indicates a great fall of irritability, and then the amount of excitation required remains uniform till quite the end of the muscle. Is the uniformity which is observed in the middle piece in contradiction with the undoubted curve of irritability which exists towards the cerebrum? Kühne considers the law to hold good, and accounts for the uniformity noted by the multiplication of the primitive nerve fibres increasing the points of attack. The sudden ultimate fall he ascribes to the total absence of nerves in the ends of the sartorius. He then tests this last hypothesis by means of the ascending constant stream. He so arranges a sartorius and its nerve that the constant ascending stream can be applied at will. The electrodes of the Rheochord apparatus are then applied to a central piece of the inverted sartorius, and the amount of new-silver wire, necessary to be introduced in order exactly to produce contraction, is measured. If these electrodes be then transferred to the extremity of the muscle it is found necessary to introduce nearly thirty centimetres of new-silver wire into the circuit in order to induce contraction. The electrodes are then restored to the neighbourhood of the hilum, and the new silver wire reduced, and the nerve is suddenly brought under the influence of the ascending stream. It will then be found necessary to introduce the same amount of new silver wire into the circuit to induce contraction as when the excitation was applied to the extremity of the muscle, and this intensity of stream will now be found uniform for the whole muscle. Thus all the differences between the various sections fall away as soon as the nerve is fairly paralysed by the ascending stream. The total irritability of the muscle is reduced by the electrotonic condition of the nerve, and a determinate minimum of irritation is found for the muscular tissue itself, contrary to the assertions of Eckhard, who appears to have only used the minimum stream for the nerve as a muscular excitant, whilst his nerve was in anelectrotone. It is probable that the minimum of irritation only affects the nerves of a nerve holding muscle. When the minimum is exceeded both organs are attacked. The minimum of exciting force for the muscular

tissue being thus ascertained we have a means of tracing the nervous distribution in the nerve-holding sections. If the electrodes be so closely opposed as only to include a few primitive fasciculi of the muscle, a quite local contraction of these few fasciculi alone will ensue. This is true both of the nerveless and nerve-holding sections. If a branch of nerve chance to be included, forcible contractions of a large tract or of the entire muscle will result. That a much diminished intensity of stream suffices to do this shows that the observer is dealing with the intramuscular nerve. Hence close to the entrance of the nerve trunk there are spots devoid of nervous tissue. Here, of course, it is impossible to imagine that the paralysing influence loses its energy owing to the remoteness of the immediately influenced spot.

We now pass on to the experimental evidence of the capacity of a motor nerve to conduct excitations as well towards the centres as from them, in other words to the capacity to carry stimuli in a double direction. Of the anatomical fact that the ultimate nerve fibres sub-divide we need give no proof. The object of experimentation is to demonstrate nervous retrograde conduction by means of muscular contraction. This might easily be decided if it were possible to isolate a secondary nerve-fibre and the muscular fasciculus corresponding to one limb of the bifurcation. Every contraction of the fasciculus on irritation of another branch of the parent nerve fibre were evidence that the latter carried the excitation upwards to the point of bifurcation, whence it descended to the muscle. This isolation can be effected physiologically by two methods. The contractile substance of a portion of the muscle may be destroyed by an agent which is incapable of injuring the nerve. There are many such: distilled water of 40° C, hydrochloric acid of 0·1 per cent., sulphocyanide of potassium of 1 per cent. Or the upper end of a sartorius may be dipped into oil of 40° C. The contractile substance coagulates, but the nerve for a while retains its conducting power. If sections be then made in the nerveless zone, between α and β no contractions follow, but if between β and γ (Plate X, fig. 2), very limited ones will ensue in that part of the muscle which has not been exposed to the re-agent. This may be confirmed by the use of the mineral acids, or of sulphate of copper which, being pure muscular excitants, cause no contractions, whereas glycerine and potash induce them. Still this is an uncertain experiment. A better method is to split the upper extremity of a sartorius longitudinally for 7—8 millimetres. All sections of the one limb that may be made below the line a fig. 3, cause contraction of the half of the muscle A solely, but

sections between *a* and B simultaneously cause fibrillar contractions in the half B. The chemical tests may be resorted to as above for confirmation. It will then be found that pure muscular irritants engender contractions only in those fibres to which they are applied; to induce contraction in the other segment of the muscle nerve excitants must be employed. It might be objected that the contraction which is carried from one part of the muscle to another was to be ascribed to an excitation of the nerves by means of the negative stream oscillation caused by the contraction of the directly irritated muscular fibres. Now it is certainly true that the muscle evinces the negative stream oscillation both on direct mechanical and on chemical excitation, because secondary contractions of a rheoscopic muscle can be obtained by means of it. But the negative oscillation of the muscular stream is an irritant that can only affect very excitable nerves. Thus it is only possible to propagate the contraction of one sartorius to another muscle if the sciatic plexus be employed. The lower parts of the sciatic nerve are not sufficiently irritable. Hence a muscle during contraction cannot excite its own nerve, as the negative oscillation of its stream impinges upon the nerve at the point where it is least excitable. The circumstances that all excitations of the nerveless terminal zone only act on the fibres irritated, and further that even in the nerve-holding region nerve excitants alone suffice to evoke contractions in the not directly excited fibres clearly show that we have not to deal with mechanical draggings by means of which the contracting part of the muscle could excite the nerves of the not directly irritated parts. It has further been objected that this contraction of both halves of the muscle depended on the formation of a double loop of nerve. This can be experimentally disproved. If the nerve of a muscle thus prepared be laid over the electrodes of a constant battery and transverse sections be laid on the one limb of the split, a point will be reached when the other half will also contract. Let the circuit of the battery be now closed so as to put the nerve into anelectrotone; a fresh section will only cause contraction of the fibres divided. If the stream be again opened, a fresh section will cause contraction of both halves. Now, presuming a loop to exist, after it had been divided the distal piece of nerve could not be affected by the anelectrotone. The incision would, at the same time, act as a stimulant and remove it from the influence of the anelectrotonic centre (Plate X, figs. 4 and 5). This can be further proved by a converse experiment. Let the split be advanced to near the hilus, where there are many nerve loops. Then divide the one limb close to the point of bifurcation. Contraction

of the opposite limb will always occur, whether the nerve be exposed to the ascending stream or not. The same holds of chemical excitants. If the one section be dipped into concentrated glycerine, contraction occurs in both halves of the muscle. If the paralysing stream be now closed, it ceases in both. Thus it can only be by branching of the primitive nerve fibres that the irritation can be conveyed. This method of experiment Kühne used as a test for the whole series of his chemical excitants, and found his previous observations confirmed.

The subject of the varieties of muscular contraction is one well worthy of attention. Schiff, who has laboured to a considerable extent in the same field as our author, has recently attempted to discriminate between the contractions which result from nervous excitation and those due to direct irritation of the muscle. He designates as neuro-muscular a contraction which extends from end to end of the muscular fasciculus and which may be excited primarily either by direct or by nervous irritation. This form of contraction he takes to be the one paralysed by the constant ascending stream. He regards as idio-muscular a contraction strictly confined to the site of irritation. "A small tumour arises which may last for several minutes as a persistent, tônic contraction. It is always slow and never pervades a whole fibre. Idio-muscular contractions are never induced by the galvanic stream, whilst chemical or mechanical excitation causes them strongly."* Certain *primâ facie* objections meet this interpretation. It assumes that the contractile substance is devoid of the power of conduction. The contraction following excitation of the nerve would require to be thought excited at all points simultaneously. Now, with the facts already discussed, this must either involve an effect in distans, beyond the material limit of the nerve, or the evoked contraction must be of so peculiar a character that only when it is called into being is the excitation capable of propagation to every consequent point of the contractile substance. Again, in direct electrical excitation, the intramuscular nerve alone is excited when the minimum of electricity is employed. If this minimum be exceeded by a certain determinate amount, paralysis of the nerve by the constant stream does not neutralize contraction. It may, however, be doubtful whether the electrical stream has acted directly on the contractile substance, or whether the paralysing influence on the nerve-trunk has only sufficed to reduce the irritability to a certain uniform level. To solve this question Kühne cut a sartorius into square

* Physiologie, pp. 21—24.

blocks, and opposed these by their cut surfaces, placing the two external ones in contact with the blotting-paper electrodes. The minimum of electricity, which admits of estimation by the induction coil, or by the Rheochord apparatus, will always cause only one segment, viz., that which contains the nerve-trunk, to contract. If the irritation be then increased, the piece next the hilus contracts, and lastly the pieces opposed to the electrodes. If these last pieces exclusively be employed, this last intensity of stream will be that which will induce them to contract. The author thus vindicates the individual character of muscular contractility and its faculty of propagation from section to section of the sarcous tissue. He is inclined to restrict the terms neuro and idio-muscular to those contractions that can be induced severally by indirect or by direct excitation. In both the contraction propagates in every direction within the sarcolemma.

Still that local spasm, which Schiff regards as idio-muscular, really exists, and it is necessary to have an exact idea of its nature. When a certain number of primitive fibres are irritated, say, by a needle being drawn transversely across them, they instantly contract in their whole length. When this true contraction has subsided, the site pressed upon gradually rises above the level of the surrounding muscle, so as to constitute a blunt mound exactly corresponding to the line of pressure, and which gradually disappears. Schiff has placed this contraction on a level with *rigor mortis*.

But Czermak has shown that a frog's thigh, whose nerve touches on the one hand the quiescent muscle, and on the other this idio-muscular tumor, passes over into secondary contraction; and this Kühne confirms. He has even found the same experiment to answer with warm-blooded animals. It might be inferred from this that the muscular stream at the excited point was either engaged in negative oscillation or in persistent decrease, and the experiment would be decisive for the question were it not certainly to be assumed that an absolute local destruction of the contractile substance would have precisely the same effect, inasmuch as the destroyed muscular substance could still serve as a conductor to the normal section of muscle in contact with it, so that the secondary contraction would only have the value of contraction without metal, of the contraction induced by the quiescent muscular stream. The fact, however, that these idio-muscular tumors can be repeatedly produced on the same spot argues that the secondary contraction which they bring about really is due to the negative oscillation of the muscular stream, although it remains a curious fact that no tetanic condition of the frog's thigh, analogous to

a secondary tetanus, should correspond to this permanent contraction. This last fact renders it probable that the permanent contraction, after mechanical irritation, represents the sole persistent muscular contraction as contrasted with the tetanus hitherto recognized. That it is totally distinct from *rigor mortis* is obvious, the phenomena of gradual disappearance and of reproduction even set aside, from the absence of all those signs that characterize rigor. A transverse section of such a tumor never has an acid re-action, and retains its transparency. Can we then bring this variety of contraction into conformity with that already discussed, and is it possible to abolish the use of the terms neuro and idio-muscular, as employed by Schiff, altogether? This is the view taken by Kühne. He remarks that Schiff has apparently overlooked the immense difference between the amount of irritation in a directly and in an indirectly affected spot. A strong analogy can be derived from nerve. A nerve can be destroyed at a given point by an irritation, but the spot adjacent to it may propagate the irritation without being also injured. The same holds of muscle, and it is not surprising that the muscle contracts more forcibly at the point where it is directly irritated than where one excited section serves as an irritant to the next. The appearance of the tumour subsequently to the general contraction depends upon the muscle being first pressed down by the irritant, and also requiring time to exceed the contraction by which the whole muscle has added to its thickness whilst in the quiescent state.

Schiff has further referred to the occurrence of a peculiar form of muscular contraction as the result of mechanical irritation of muscle, a considerable time after the death of the animal. If a sharp instrument be run across fibres that are no longer at the acmè of irritability a beautiful series of waves will run along the fasciculi in both directions. As the directly irritated spot rises to form a tumor, waves of contraction emanate from it, run to the end of the muscle and thence return. That this is a modified contraction is evident from its capacity to induce secondary contraction in a rheoscopic thigh. As the muscle dies these changes become more decided. The tumors are lower, occur later and last longer. But the contractions emanating from them undergo a similar change, so that a wave-like contraction can only be regarded as a slower form of the usual muscular contraction. At a last stage the idio-muscular tumor was itself seen by Kühne to divide into two slowly diverging waves of contraction. How then comes the idio-muscular tumor to be formed? The method of irritation affords the key to this. The more a muscle is fatigued, the easier is idio-muscular tumor obtained, and the

fatigue is proportionate to the amount of violence applied. In each experiment the site of irritation is fatigued, and hence the contraction which there ensues assumes an exhausted character, *i.e.*, occurs later and lasts longer. If the exciting medium be electricity, and the electrodes fine points, nodules will arise directly beneath them immediately after the contraction corresponding to the closure of the circuit has taken place. If this stream be passed transversely across a number of fasciculi only those directly under the electrodes contract. The density of steam does not suffice to excite the intermediate fibres, although at the points of contact it may be considerable. The fibres close to the electrodes, however, contract in their entire length; but at the electrodes the second condition, fatigue occurs, and a local, persistent contraction results. As the muscle dies out a wave of contraction may only start from the one pole, or the persistent contraction may only occur at one pole. It is probable that the products of electrolysis at the negative pole are active at a time when those at the positive pole have ceased to have any exciting power.

To sum up Kühne's arguments in favour of the individual character of muscular irritability they may be grouped thus:

I. Contraction of the muscle on direct irritation during palsy of the nerve by the ascending stream, the anelectrotonic nerve being inaccessible to chemical agents.

II. The contraction of the muscle on irritation of sections devoid of nerves.

III. The peculiar character of the contraction on the local application of such irritants to individual fibres as only act on the sarcous tissue.

IV. The difference of the contraction after local excitation when the extreme end of the intramuscular nerve is simultaneously excited, which rests on the capacity of the motor-nerve fibre to conduct in a double direction.

We have found Kühne asserting that it was not possible to determine this question by means of Curari. It remains for us to give an outline of what he holds to be the actual working of that poison. We will first consider its influence on the nerves which lie within the muscle. We have seen how the author disposed of the "local" contractions after poisoning described by Kölliker. Haber, also, we have noticed as speaking of a variety of "local" contraction different from that observed by Kölliker, inasmuch as, although limited to the fibres excited, it ran along their entire length. But we have also seen how these local contractions could be induced in unpoisoned muscles. Let us now refer back to the curve of excitability of the intramuscular nerve, the maximum point of which is at the entrance

of the nerve, and which gradually sinks as the nerve is distributed. We have seen that sudden palsy by anelectrotone could reduce the muscular irritability to a point below any existing along the curve of excitability. We thus know how a muscle should behave according or not as its nerve participates in a given irritation. This is a clue to determine the paralysing intensity of Curari. But first it is necessary, by a comparative experiment, to define the extent to which Curari poisoning reduces the irritability of nerve. Kühne drew a ligature round the iliac artery of one thigh, and another under the artery and sacral plexus, round the animal. Thus the access of poisoned blood to the one limb was prevented. He then poisoned the animal, and next drew corresponding ligatures round the opposite limb. This precaution is necessary in order to render the results strictly comparable. The muscles of the poisoned limb were found less irritable than those of the unpoisoned one; and this difference was most marked at the hilus. The nerveless zones, on the other hand, yielded perfectly uniform results. He, however, found the same distinction between sections rich in nerves and those poor in nerves, in the poisoned as in the unpoisoned muscles. This was true, whether tetanizing with the induction coil, or the closing contraction of the stream with the constant chain, when the Rheochord is the measure, be employed. Or the muscles might be excited by being divided into corresponding sections, the whole being laid on paper moistened with syrup of ·05 strength, so as to be simultaneously excited by the same intensity of stream. Thus, a muscle poisoned by Curari behaves like a normal muscle in all respects except that the differences between the various sections are smaller.

We now come to compare a poisoned muscle with one deprived of its nerve by anelectrotone. Two muscles, one of which is previously poisoned as above indicated, are so arranged that their hilus shall be close to the electrodes of an exciting battery; the nerve of the unpoisoned one—say the left,—is moreover carried over the zinc electrodes of a strong six-celled Grove's chain, by which an ascending stream can be passed through it. The relative irritability of the two muscles being previously tested, and that of the left being found greatest, the ascending circuit on its nerve is closed. Closure of the exciting weak chain will now only cause contraction of the right poisoned muscle, whilst the left, which previously contracted powerfully, remains at rest, or only contracts when greater resistances are introduced into the Rheochord. Now, as the latter has the relations of a muscle devoid of nerve, the conclusion is, that the poisoned muscle, whose contractile sub-

stance is on the same footing, retains a certain portion of nerve force which has been spared the action of the Curari. Kühne now raises an objection to his own experiment. The poisonings had only lasted for a few minutes. What other changes might occur on a longer contact with the poison?

We have seen glycerine, in the undiluted condition, to be a constant nerve-excitant; if the muscle contain any active nerve-tracks, these should be accessible to it. But here Kühne found himself at fault. After poisoning the application of glycerine to the first nerveless section caused contraction. The pure contractile substance behaved otherwise after poisoning than before. But another test presented itself to the author. A saturated solution of cane-sugar in water, when applied to the nerve, caused the most violent contractions, ending in a decided tetanus. Applied to a nerveless section, it evoked no contraction. In a nerve-holding section it caused a tetanus which the rapid application of anelectrotone could remove. A muscle poisoned with Curari behaves in its nerveless sections like a normal one. Here, then, the difficulty presented by the glycerine does not exist. Kühne now found that when the poisoned nerve-holding sections were dipped into the syrup, contractions ensued, although less forcibly than in unpoisoned sections. They were also restricted to individual fibres. This receives its explanation from the fact that an excited nerve-termination can only influence the fasciculi which pertain to it; whilst, in healthy nerve, every excitation of a peripheral end can affect many muscular fasciculi by centripetal conduction and transference by means of divided primitive nerve-fibres. Advancing a step further, can Curari ultimately affect the final terminations of the nerves? This is actually the case. A poisoning with 0·001 gr. of Curari—a maximum dose, —induces it in about two and a-half hours. This, however, is naturally quite inapplicable to explain the absence of contractions on irritation of the nerve-trunk immediately after poisoning. For this it is necessary to examine the influence of Curari on the motor-trunks.

The experiments of Bernard and Kölliker led to the assumption that paralysis advanced from periphery to centre; and it remained to be ascertained if Curari could affect the nerve-trunks when not applied through the capillaries of the muscle. Our limited space obliges us to pass over the experiments of Kölliker and the objections of Funke, till we find the latter analysing the electromotor relations of the nerve-trunks of poisoned frogs. These he found identical with those present in the normal nerve, *i. e.*, the quiescent nerve-stream, the two phases of electrotone; and lastly, on irritation, the negative

oscillation of the nerve-stream. Thence he concludes that the nerves retain their irritability as in the normal state. Kühne denies that these conclusions are logical; and he asserts that the nerve-trunks, in spite of their normal electromotor relations, entirely lose their irritability after Curari poisoning. He does not consider that the experiments of Bernard and Kölliker prove that the palsy creeping up towards the centres attains to the nerve-trunks. To establish this he adopts a method the reverse of that hitherto employed, and observes the gradual recovery of the animals from the effects of the poison. He first ascertained what was the minimum dose with which a frog could still recover, and found it to be 0·00004 gr.,—a dose sufficient, in an hour, completely to paralyse it. Usually, at the expiration of twenty-four hours the first weak contractions were seen to return on exposure of the nerves to strong induction strokes. The nerves of animals that, to external observation, appeared quite palsied, behaved very differently accordingly as the electrodes were applied to a central or a peripheral spot. Some muscles which responded to no kind of irritation applied to the nerve-trunks, went into violent general contractions on the application of the minimum stream to their nerve-holding sections. As poisoning is ceasing, those nerve ends which lie in the muscle acquire their irritability earliest. But this also shows that the trunks must be paralysed. If the nerve be examined a little later, a strong induction stroke applied to that portion of the sciatic which lies nearest to the muscle will be found to cause contraction, whilst a stroke of equal intensity applied to the plexus itself, produces no effect. If examined with the Rheochord, the normal curve of irritability will be discovered in the peripheral portions of the nerve, fading away from a given spot till a point is reached in the direction of the centres beyond which all induction strokes are powerless. Thus the trunk of the nerve, even in poisoning with minimal doses, is paralysed in its whole extent; and this condition, in the return to the normal state, gradually vanishes from periphery to centre. Thus a nerve may retain its normal electromotive properties, although quite incapable of passing into the excited state and of inducing muscular contraction.

Kühne's theory of Curari-poisoning is, then, as follows:—The poison is resorbed by the blood-vessels, and first paralyses a portion of the intramuscular nerve, close to its extreme end. Then the motor nerves are progressively paralysed from periphery to centre in their whole extent. Recovery ensues in the same order as paralysis. After poisoning has long persisted the ultimate end of the nerve participates in it. The intimate

and extended relation that the muscular capillaries bear to the intramuscular nerves probably explains the facility with which the poison affects the nervous system when applied through this channel. Indeed, it admits of little doubt that the blood changes in the muscle are the greatest means of nutrition in its entire course. Brown-Sèquard has shown, that if the vessels of the leg of a warm-blooded animal be tied, and a large tract of the nerve isolated, irritation of the latter causes no movement of the limb, although the muscle remains directly irritable. If blood be then again admitted, the nerve regains its power in a few minutes. Now, in so far as the anaemic nerve-trunk loses its irritability along its entire course from the intramuscular distribution towards the centre, this experiment stands parallel to Curari poisoning. To test this, Kühne repeated Brown-Sèquard's experiments, testing the different portions of the nerve after the readmission of blood. In a few minutes the piece of nerve next the hollow of the knee was found irritable; but a point a little higher up the nerve was still paralysed. Somewhat later, irritability reappeared also here, at first feebly, then decidedly.

A collateral subject has also been carefully investigated by Kühne, namely, that of the nature and physiological bearings of Rigor Mortis. We should scarcely be doing him justice without a brief notice of his contributions in this direction. Without going into the opinions of the authors who have written on this subject, it will suffice to state, that a muscle in Rigor Mortis is hazy, opaque, and acid, whereas a still irritable one is transparent and alkaline. This, in general terms, Kühne confirms, but quotes, as exceptions, the sections of the still pulsating heart which are acid, whilst the rigid muscles of a rabbit starved to death were alkaline.

The experiments of Brown-Sèquard,* Stannius,† and others, would seem to indicate that the rigidity which can be induced by tying the arteries of a part, may be resolved by readmitting the blood. To this conclusion our author demurs. A thoroughly unexcitable and rigid muscle can never be converted by the blood current into an excitable one. He cut off the circulation from the thighs of frogs. A time was at length reached, when the muscles were still fully excitable, but could make no voluntary movement, and when irritation of the sciatic, either above or below the ligature, ceased to cause any contraction. If the ligature be then removed, we obtain, as above said, a gradual restoration of the terminal nervous organs.

* Comptes Rendus, 1851. † Müller's Archiv., vol. xi.

In other animals, after applying the ligature the muscles were from time to time tested with the induction apparatus till no further reaction followed direct irritation. Then the one thigh was amputated below the ligature, whilst the circulation was restored to the other. In more than fifty trials, he never saw irritability return, when the muscles were really rigid, *i.e.*, hard, sour, and opaque, but the return of blood always induced rapid decomposition. As a test for the return of irritability, he applied the strongest induction strokes, and acids, and alkalis. Now, in the muscles of cold-blooded animals, a stage occurs when no method of excitation will induce them to contract, but still they are not rigid, but transparent and alkaline. If then a dilute acid or alkali be applied, those fibres which reacted to the induction strokes get violently contorted, and then suddenly become brown and opaque, but at last gradually clear. The first movements are the results of chemical irritation, the opacity equals the rigor of short duration, and this is followed by chemical solution. But those fasciculi which resisted the excitants, pass at once into rigor. Thus, in frogs, Rigor Mortis cannot be a contraction, as for a period prior to its supervention, the muscles are incapable of contraction, and this intermediate period is never absent. Should nutrition be again afforded to the muscle during this period, it will again react to all muscular stimuli. Hence the not yet rigid, but still not excitable muscle, may again resume its irritability. To transfer these observations to warm-blooded animals, Kühne exarticulated the hip joint of a dog, and cut through all the soft parts except the artery and the veins; these latter were ligatured. After six hours, irritability had ceased even in the deep muscles of the thigh, and they were quite rigid and acid, whilst a portion of the gastrocnemius remained alkaline, and just irritable; the ligature was then loosed; the animal survived one and a-half hours. No change occurred in the muscles of the thigh, but the gastrocnemius could soon conduct contractions along its entire length on stimulation. At death, the thigh muscles were again alkaline, and deeply imbued with blood colouring matter; next morning all the muscles were acid except those of the thigh, which were putrefying. These results Kühne considers quite in harmony with those of others. Stannius saw restitution only of such muscles as remained excitable. All these phenomena would seem to indicate the coagulation during rigor of some material which had been maintained fluid during life. Various observers, Brücke, Simon, Virchow, have asserted that they had obtained it. Kühne injected the limbs of frogs with a solution of 5 to 1 per cent. of a solution of chloride of

sodium, a fluid that may long remain in contact with the muscle without causing rigor. The blood being thus washed out, the muscles of five or six frogs are dissected out and brought under a press; a strongly opalescent alkaline fluid is obtained; in it a clear gelatinous clot gradually forms, presenting a mucous, ragged appearance under the microscope, and becoming hazy on the addition of water. The residual mass of muscle shows no evidence of rigor, and remains alkaline; next day, the fluid will be found full of white flocculi, and if it has been preserved in a warm room will be acid; at low temperatures this body coagulates slowly. At 0° C. it has been kept for weeks, but then at once coagulates in a warm room, or ultimately spontaneously. A temperature of 40° C. at once coagulates it. The fluid may from first to last remain alkaline, and in so far differs from the muscle. In order to prevent acidity, it should be carefully filtered from the mucus which is expressed with it. Acidification and coagulation may occur simultaneously, but are not necessarily connected. Water hastens coagulation. Solutions of chloride of sodium within the limits above-mentioned retard it.

An important question here arises. Is heat, a muscular excitant? Kühne used neutral olive oil and mercury warmed by a water bath as media for its application; the results observed at high temperatures were exceedingly irregular; even at from 50° to 45° C., contractions were very rare; at 37·5° C. after a considerable interval, the muscle became slightly rigid; if then exposed to the induction apparatus, the secondary coil required approaching considerably to set up contraction. Such a muscle never became more excitable after a period of rest, but went on to further rigidity; a little longer exposure to this temperature sets up that intermediate, transparent state of inexcitability, of which mention has been made. This is quickly followed by complete rigor. At 40° C., rigor is immediate; if the muscles of living frogs be dipped into oil of this temperature, they at once become rigid, their circulation continuing active. These limbs never lose the rigor, or regain their irritability; here the muscle does not decompose as after ligature; it retains its alkaline reaction, becomes imbibed with blood colouring matter, but does not endanger the life of the animal; it undergoes a kind of granular fatty degeneration and softens, but never again becomes contractile. Thus the rigor of warmth at 40° C., is a decided coagulation. We have seen 40° C, to be the instant coagulating point for the expressed muscular fluid.

Now the contractile substance contains other bodies which,

although they do not coagulate spontaneously, do so at a temperature little beyond 40° C. A rigid muscle exposed to a heat of 45° C., becomes more rigid and opaque; the shortenings of such a muscle cannot be referred to contraction; the fluids causing it may be obtained by expression from rigid muscles, and its coagulating point will he found invariably 45° C. It may also be obtained from the fluid obtained by pressure before rigidity, if the spontaneously coagulating body be previously filtered. The last traces of an albuminous body fall at a temperature of about 90° C. Are any of these bodies allied to Syntonin? Liebig's Syntonin does not coagulate spontaneously. It can also be only obtained by the use of dilute acid, which rapidly induces decided rigidity; it does not coagulate even on boiling, only if the solution be carefully neutralized, do flocculi fall, and an excess of alkali dissolves them. A muscle whence the coagulating bodies have been abstracted by pressure, will yield Syntonin to dilute acid.

Lastly, what is the state in which the coagulating bodies occur in muscle? It appears probable that contractions are under all circumstances equivalent to wave-like movements. The possibility of this is evidently coupled with a fluid condition of the contractile substance. A contraction must be so imagined, that a change of position occurs, in which the particles of the fluid quit their original sites, so to arrange themselves on the cessation of the force which induced the change of position as their weight requires them to lie. Hence a muscle after contraction never returns to its original position, without the addition of some external force, but remains in that condition of equilibrium, which is not by any outward sign to be discriminated from the state of contraction. In an irritable muscle we have a concentrated solution of albuminous bodies, in a rigid one, a firm clot. Our space will not allow us to go more fully into the many interesting topics broached in this series of papers, but it will suffice, if we have indicated the general directions at the present taken on the continent, by the question of Muscular Irritability.

Part VI.

ANALYTICAL NOTICES OF BOOKS AND PAPERS.

The reports will be purely analytical. Critical notices are inadmissable in this journal. If the authors of original papers and essays will transmit to the editor a brief summary and simple statement of the results at which they have arrived, with their printed communication, this department of the journal will be rendered more complete. Pamphlets and short papers (English and foreign) on subjects connected with medicine and surgery, which are not generally noticed in reviews, will be included in the analytical notices.

On the treatment of Intrauterine Fibrous Tumours. By T. H. Tanner, M.D., from the "London Medical Review."

There are many cases in which fibrous tumours (polypi) exist within the cavity of the uterus, and give rise to one important symptom—hemorrhage. This symptom is generally treated by the use of astringents, which agents, however, fail to be of real service. The object of Dr. Tanner's paper is to show that there is less danger to be apprehended from dilating the os uteri with sponge tents and removing the tumour, than from leaving the cases to nature.

A sketch of the Life and Works of Erasmus Darwin, M.D., F.R.S. By John Dowson, A.M., M.D.—Horne and Son, Whitby.

This little work, of sixty-one pages, consists of a lecture given by Dr. Dowson to the Literary and Philosophical Society of Whitby. Numerous notes and an appendix, on the origin of species, selected from the works of Dr. Darwin, are added. The "Zoonomia" was published about the year 1771. Numerous extracts from this work are given, as well as several passages from Dr. Darwin's last poetical work "The Temple of Nature." Dr. Dowson brings forward several quotations to show that Dr. Darwin's views have much agreement with those so recently put forward by the author of the "Origin of Species;" but he remarks that "though the two Darwins agree in their main conclusions as to the past history of the organic life of the globe, and support their opinions by very similar if not identical arguments, they differ much in their anticipations of the future."

A Manual of the Practice of Medicine. By T. H. Tanner, M.D., F.L.S., etc. Fourth edition. 1861.

This work continues to embrace all the more recent medical discoveries. In the chapter on morbid states of the blood Virchow's additions to the history of blood-crystals, together with Coote's researches on piarrhæmia, are introduced. The article on glucohæmia is brought up to the most recent standard by an analysis of the opinions of Harley and Pavy. The interesting question of the depositions of fibrin in the heart and great vessels is also examined, and an instructive case observed by the author is appended. Under the head of inflammation, the doctrines recently propounded by Dr. Hughes Bennett are carefully analysed, and are to some extent adopted by the author. A paragraph is introduced on the question of amyloid degeneration. In the chapter on diseases of the nervous system, the treatment of delirium tremens by large doses of digitalis, as advocated by Jones, of Jersey, is alluded to; and an instructive critique is introduced on the opinions recently expressed on the part performed by alcohol in the economy. Brown-Sèquard's investigations also attain their due importance in the article on paraplegia. An extended article is inserted on diptheria. The authority of Frerichs is referred to on the question of acute hepatic atrophy, etc., etc.

Epileptic and other Convulsive Affections of the nervous system. By Charles Bland Radcliffe, M.D., etc.

The author regards convulsive affections in a light very much at variance with that commonly received. An elaborate physiological introduction precedes the more strictly medical portion of the work, with the object of vindicating for living muscle a state of polarity during relaxation, such as to lead to a continuance of that state, so that contraction is to be regarded as nothing more than the necessary result of the muscle being liberated from it and left to the operation of the attractive force which is inherent in the physical constitution of the muscular molecules. After proving by quotations from Dr. West (Alford), Dugès, Matteuci, Engel, etc., that his fundamental idea has no claim to absolute novelty, the author proceeds in a series of chapters to lay the physiological evidence before his readers. He begins by referring to the experiments of Stannius on the relaxation of the rigor mortis by the injection of fresh blood, and on the converse experiment of ligature of the abdominal aorta. The experiments of Brown-Sèquard on the agency of venous blood in producing convulsions are next given; but his inferences are disputed, and the spasms are referred rather to

the absence of arterial than to the pressure of venous blood. In confirmation of this Draper's experiments on asphyxia and the effects of severe hemorrhage are quoted, as are also the experiments of Dr. Harley on the effects of strychnia and brucia in preventing oxygenation of the blood. The inference drawn is that blood is not the stimulus to muscular contraction. A considerable amount of evidence is adduced to show that muscular contraction may occur in its most exaggerated form, under circumstances in which a large amount of nervous influence would seem to be withdrawn; and the experiments of Küssmaul and Tenner are especially insisted on. In a special chapter the electrical relations of muscle and nerve are largely discussed first in reference to instantaneous and continuous currents, and then in relation to the electricity inherent to them. Under the first head Chauveau's experiments on the seventh nerve indicating the importance of the negative pole are quoted and are followed by the arguments of this observer, referring the contractions which ensue in the closure or opening of the electric stream along enfeebled nerves, to the initial and terminal extra currents which are severally set up according as the currents are direct or inverse; the initial and terminal extra currents being always in the reverse direction to the induced ones. Acting on this the author explains how contraction should attend the closure of the circuit when the current is direct, its opening when it is inverse, by shewing that the nerve has lost it power of responding to stimuli at the pole furthest removed from the muscle in either instance. In analysing the inherent electricity of muscle and nerve Dr. Radcliffe reminds his readers that the deviation of an astatic needle is greater under the influence of a relaxed than under that of a contracting muscle; and that the primary nerve-current is centripetal. After alluding cursorily to the action of strychnia, in reducing the amount of deviation of the needle, he analyses the effects of a continuous galvanic current on the incitability of nerve, and quotes many of the experiments of Eckhard on nerves exposed to a continuous inverse current; coupling these with the results obtained by Du Bois Reymond, he infers that contraction is absent when the original nerve-current is strengthened; present when it is weakened, as by a direct current. He refers the agency of the induction-coil in causing contraction to the establishment of induced currents, extra currents, and molecular disturbance, all of which weaken the original nerve-current, and he shews how their effects may be neutralized by the addition of the inverse current. The general deduction drawn from these and other facts is that contraction is due not to stimula-

tion of the vital property of muscular irritability, but to a disturbance in the electro-motive molecules. Hence nervous influence must antagonize contraction, and convulsion may be set up by arresting the supply of blood to a centre. Rigor mortis he refers to the total absence of electrical tension and to muscular anæmia. The author then applies these deductions to the explanation of the system of the heart, which he refers to temporary anæmia of the ganglia of that organ, and then considers the movement of the intestines and those of respiration. Many other points of physiological interest are also discussed. Passing to the pathological portion of his work, the author argues that the interparoxysmal state, the pallor preceding the fit, and the post mortem appearances, are indicative of dimished rather than of increased action, and that the different states of morbid irritability to which the fits have been ascribed, *e.g.*, teething should be considered as equivalent to inefficient innervation. He is consequently in favour of a sustaining plan, both generally and medicinally, and speaks well of steel, cod-liver oil, naphtha, the ethers, etc. He is not very zealous for any specific. The other convulsive affections are also reviewed in accordance with the above, and an elaborate attempt is made to fathom the pathology of chorea. Finally incidental spasms are referred to.

Sore Throat and the Laryngoscope. By Dr. Prosser James.
The plan of the book is simple. In the first part Dr. Prosser James gives a general brief sketch of his subject; in the second the more important diseases of the throat are separately considered in detail; in the third a selection of cases, illustrative of the novel points mentioned, are formed into an appendix. It was of course impossible, in some points, to state anything new; a sketch, therefore, of other subjects on authority completes the outline. The diseases are severally succinctly described, and the various discussions to which they have given rise are briefly alluded to. The author warmly advocates the value of tincture of aconite in this class of affections. He says, "although I have used it in thousands of cases I have never produced alarming symptoms of poisoning, and I know of no medicine which less frequently disappoints my expectations." His usual dose is two minims of the pharmacopeial preparation. Corroborative cases are given. The relation of ovarian irritation to tonsillar affections is also insisted on and illustrated by cases. Dr. Prosser James claims to have contrived and used the laryngoscope before it was introduced by Czermak into this country. Case 12 (appendix) shows how he illuminated the

pharynx, and by a mirror discovered and applied nitrate of silver to ulcers of three years standing as early as 1856, and after several had failed to make out a diagnosis. In the face of a dispute in Germany as to priority, Dr. Prosser James claims credit for completing Liston's idea without German aid. Although not expecting at that time to see the vocal cords, the plan of the laryngoscope was complete, and a perfect pharyngoscope was proved useful.

The relations existing between Urea and Uric Acid. By William Hammond, M.D., Assistant Surgeon, United States Army. 1855.

The results of some experiments are here given, made with the object of ascertaining whether the theory of Liebig in regard to the formation of urea from uric acid could be sustained by further investigation. The first series of experiments the author performed upon himself, regulating his diet and analysing his urine, whilst he severally took much, little, and no exercise. The second series was performed upon a black snake (Coluber constrictor), the execretions of the animal being measured whilst it was confined in a jar, at first supplied with atmospheric air and afterwards with oxygen. Both series of observations tend to confirm Liebig's view.

The physiological effects of Alcohol and Tobacco upon the Human System. By William Hammond, M.D., etc. 1856.

The effects of alcohol were observed when the weight of the body was maintained at a nearly uniform standard by a sufficiency of food, when the body lost weight from a deficiency of food, and when it gained weight from an excess of the same. The weight of the body, the quantity of carbonic acid and aqueous vapour, expired in respiration; the weight of the feces, the quantity of the urine, and the amount of its free acid, urea, uric acid, chlorine, phosphoric and sulphuric acids, were severally determined. The author arrives at the conclusion that alcohol increases the weight of the body by retarding the metamorphosis of the old tissues, promoting the formation of new, and limiting the consumption of the fat. The carbonic acid and aqueous vapour of respiration were diminished, the feces and urine were reduced in amount, and all the salts of the latter were lessened in quantity. His experiments with tobacco lead the author to infer that it has no material effect on the excretion of carbonic acid from the lungs, but that it lessens the amount of aqueous vapour given off in respiration. That it diminishes the amount of the feces, and lessens the

quantity of urine, together with the amount of its urea and chlorine. Lastly that it increases the amount of free acid, uric acid, phosphoric and sulphuric acids, eliminated through the kidneys.

Experimental researches relative to the nutritive value and physiological effects of Albumen, Starch, and Gum. Prize Essay of the American Medical Association for 1857. By W. A. Hammond, M.D., etc.

A series of experiments, of which the author was the subject, are here detailed with great accuracy. In every instance the urine and feces were carefully analysed, and the loss through the skin and lungs obtained by difference. A preliminary series of experiments extending over five days, during which an ordinary diet was observed, is intended to serve as a standard. A stated quantity of albumen and water was then daily consumed during ten days, the excretions being measured as before. The results obtained were a diminution of the absolute amounts of the water and solids of the urine, a very slight increase of urea, a considerable elimination of uric acid, a reduction in the chlorine, sulphuric, and phosphoric acids. The whole quantity of feces was increased, but this was chiefly to be referred to a diarrhœa which supervened on the two last days. The weight of the body declined materially, the pulse was increased in frequency, the temperature reduced. The water, blood corpuscles, inorganic salts, and fat of the blood fell in amount; whilst the fibrin, albumen, and extractives were increased, the latter remarkably so. The author next considers the capability of the digestive organs to dissolve, and the absorbents to assimilate, a sufficient quantity of albumen to support the calorifacient process, and the relation which the nitrogen of the urea and uric acid excreted bears to the amount absorbed in the albumen. He concludes, first, that the digestive organs can dissolve enough albumen to supply the system with the necessary amount of carbon and nitrogen; second, that the proportion of nitrogen eliminated by the kidneys is much less than is generally supposed; and third, that even when the body is losing weight from the oxidation of its fat, the excess of nitrogen over that escaping by the kidneys is retained in the system (over two-thirds), or that some other means of elimination exist. During the last four days, during which the experiments were protracted, albumen was detected in the urine. A similar series of experiments was next instituted with starch. On and after the fifth day the urine became saccharine, and was abundantly so towards the close of the

experiments. All the normal solids of the urine became greatly reduced; the whole body lost weight but slightly, and certainly not enough to account for the drain from the waste of the nitrogenous tissues, showing that very considerable amount of new matter must have been deposited within the system. The actual increase in the temperature of the body, and several of the pathological occurrences also show that there was no deficiency of carbon in the system. The fibrin, extractives and fat of the blood, were increased; the blood corpuscles, albumen and salts were diminished. On the whole this investigation furnishes further evidence of the incapability of starch to sustain for any length of time health or life in the human subject. A last series of experiments related to gum; but the hunger, debility, and febrile excitement induced were so great on the fourth day that the trial could not be persisted in. At last gum failed to relieve even for a short time the sensation of hunger. The solids of the urine were much reduced although the whole quantity passed was augmented. The entire amount, as also the water extract of the feces, were increased; the ether and alcohol extracts were diminished. The total loss of weight of the body was very great, and the constitutional disturbance more severe than from the exclusive use of either albumen or starch.

On the alterations induced by Intermittent Fever in the physical and chemical qualities of the Urine, and on the action of the Disulphate of Quinine. By W. A. Hammond, M.D. 1858.

A series of experiments on his own person again furnished the author with his data. During the attack he found the uric and phosphoric acids much increased in amount, and the urea and chlorine greatly diminished. During the intermission there is a close approach to the normal proportions, but a subsequent paroxysm restores the former condition. The disulphate of quinine, however, produces a permanent impression on the character of the urine.

The injection of Urea and other substances into the blood. By W. A. Hammond, M.D., etc. 1858.

The object of the experiments here detailed was to ascertain the correctness of the theory avdanced by Frerichs explanatory of the uræmic intoxication. Two series of experiments were instituted; in the first, the substances used were injected into the blood of the sound animal; in the second, the kidneys were previously extirpated. The substances injected in both series were urea, urea and vesical mucus, carbonate of ammonia, nitrate of

potash, sulphate of soda. The results obtained were that none of these substances, except nitrate of potash, proved speedily fatal; that death ensues from any of them, the kidneys being previously extirpated; that in neither case does urea, when introduced directly into the circulation, undergo conversion into carbonate of ammonia.

On the action of certain Vegetable Diuretics. By W. A. Hammond, M.D.

Digitalis, juniper, squill, and colchicum were employed, and the results arrived at tend to show that neither of the three former increases the total amount of solid matter eliminated by the kidneys, but that the organic matter is considerably reduced through their influence. Colchicum, on the other hand, increases the excretion both of the organic and inorganic solids.

Experimental Researches relative to Corroval and Vao, two new varieties of Woorara. By W. A. Hammond, M.D., etc., and S. Weir Mitchell, M.D., etc. 1859.

The history, chemistry, and physiological properties of Woorara, as given by authors, are first analysed. The chemical and physiological properties of Corroval are then descanted on and largely illustrated by experiment, the investigations leading to the following conclusions:—That it acts primarily upon the heart, thus differing essentially from Woorara. That the annihilation of voluntary and reflex movements is a secondary result of this action. That both the sensory and motor nerves are acted upon from periphery to centre. That muscular irritability is destroyed, and the sympathetic nerve primarily paralysed. That it can be absorbed both from the intestines and skins of frogs, and that its properties depend upon an alkaloid which the authors propose to call corrovalia. The conclusions arrived at with Vao, may be thus summed up. The stomach and intestines of warm-blooded animals will absorb it whilst fasting. At first, the force of the heart is increased, the number of pulsations remaining the same; then paralysis ensues, the ventricles being first affected, and the heart stopping before voluntary motion is at an end. The respiration of warm-blooded animals is arrested by arresting the circulation, and so paralysing the nervous system. Artificial respiration will not sustain the cardiac movements. The sensitive nerves are affected earlier than the motor, the paralysis going from periphery to centre. Muscular irritability is lost early. The sympathetic nerve is paralysed, at least in the upper portion of its

distribution, before the nerves elsewhere have lost their functional power. The blood coagulated as usual, and changed colour when exposed to oxygen or carbonic acid. No physiological antidote is known. Its alkaloid produces effects perfectly similar to those of corrovalia. The authors conclude, therefore, that Vao is merely a weaker variety of Corroval, and that the apparent differences in the effects produced is due to a difference in the strength of the original extracts.

On Uræmic Intoxication. By W. A. Hammond, M.D., Professor of Anatomy and Physiology in the University of Maryland, etc.

A series of experiments instituted with the object of testing the hypothesis of Frerichs. They lead to the conclusion that the injection of urea in limited quantity into the blood of animals produces a certain amount of disturbance, similar to that of the earlier stages of uræmia, but soon passing off if the kidneys are active; the injection of a large quantity of urea, however, causes death by uræmia. Ligature of the renal arteries, or removal of the kidneys caused similar results, but only when the urea or the products of its metamorphosis ceased to be discharged by the stomach or intestines. The urine, as a whole, is more poisonous than simple solution of urea, but either of them induces such a state of nervous system as strongly to predispose to inflammation of the viscera. Urea would, further, seem to check the process of sanguification, either hastening the decomposition of the red corpuscles, or interfering with the removal of such as are broken down and effete. The author considers the evidence conclusive against the conversion of urea into carbonate of ammonia, more urea being generally found in the blood taken from the body after death than in that abstracted during life.

On the State of Lunacy, and the Legal Provision for the Insane, etc. By John T. Arlidge, M.B., A.B., etc.

The author shows how imperfect are the official data referring to the number of the insane, by adverting to private lunatics and the numbers confined in prisons, workhouses, etc., thus accounting for the discrepancies in the returns made by the Commissioners and by the Poor Law Board respectively. He calculates the rates of increase of the several varieties of lunatics, and offers suggestions for obtaining improved statistics of pauper lunatics. After a short *exposé* of the curability of insanity, he divides the causes diminishing this into those external to asylums and those operating within them. Under the former head, the

detention of patients in their own houses, in workhouses, and with strangers are severally discussed, and an article is introduced on the detrimental effects of improper management prior to the admission of cases into the asylums. Under the latter, magisterial interferences, the excessive size of asylums, and the inadequacy of medical attendance are pointed out. In considering the future provision for the insane, the author urges the value of separate asylums for the more recent and for chronic cases, and advocates the system of borough asylums. He also dilates upon the advantages of separate sections, and believes the cottage system, under proper supervision, to be worthy of a trial. Considering the present staff of Lunacy Commissioners, to be inadequate, he proposes the appointment of Assistant Commissioners. In some concluding remarks on the construction of public asylums, he points out the advantage of a complete separation of the day and night accommodation.

On the Molecular Theory of Organisation. By Professor Bennett, M.D., F.R.S.E., etc., 1861.

As a protest against the new doctrine of "Omnis cellula e cellulâ," the author insists upon the great importance of the molecular element. He describes the nature and mode of origin of organic molecules, both histogenetic and histolytic. He then argues for the independent nature of the force governing these, and shows that this has no relation to cell, nucleus, or any other form of structure. He further defines what, in the present state of science, must be understood by the expressions life and vital action. Finally, Professor Bennett argues that the development and growth of organic tissues is primarily owing to the successive formation of histogenetic and histolytic molecules.

On the Estimation of Sugar in Diabetic Urine by the Loss of Density after Fermentation. By W. Roberts, M.D., etc.

The object of this paper is to supply the practitioner with a ready and simple method of calculating the amount of sugar in diabetic urine. The principle involved is, that saccharine urine, when fermented with yeast, falls considerably in specific gravity. As this must be proportioned to the quantity of sugar broken up by the ferment, the amount of this diminution supplies a means of calculating how much sugar any urine contains. Owing to its simplicity, the author believes that, in active practice, this method will be found more useful than the volumetric one now in favour.

On "Supporting the Perinæum." By Graily Hewitt, M.D., London, etc., 1861.

The presumed advantages of this practice in midwifery are contested. The effects of such support on the head of the child and on the perinæum itself are discussed at large. The author especially argues against the fallacy of directing the head forwards, which he stigmatises as actually mischievous, in ordinary cases, by interfering with its passage beneath the pubic arch. He also considers that, by pushing the soft parts forwards, the substance of the perinæum is expended in a useless manner, and that the argument that the soft parts are relaxed by pressing them forwards, has no foundation. The effects of supporting the perinæum in impeding the normal process of dilatation are then reviewed. The causes of laceration are referred to the uterus, the presenting part, the pelvis, and the perinæum itself. The author believes most of the so-called cases of rigidity to be really cases of impeded labour, due to deficient uterine power, some abnormality of the presenting part or of the pelvis. True rigidity, he considers extremely rare. As a whole, the operation of supporting the perinæum is rejected. The French practice of delivering the woman lying on her back is recommended, and care should be taken to direct the shoulders well forwards. Should laceration be actually impending, a slight incision by each side of the fourchette is advocated. In those cases where the so-called rigidity is due to some other cause, a careful use of the forceps is best.

Clinical Lecture on the Treatment of Acute Rheumatism, Pericarditis, and Pneumonia by the Eliminative Method. By B. W. Richardson, F.R.C.S.I., etc., 1861.

The practice of the late Dr. Todd in the treatment of this disorder is discussed, and a case of its application given in full. The author discusses the nature of the deposits in the valves and the physiological effects of the treatment employed.

Recherches Anatomiques sur le Corps Innominé. Par J. A. Giraldès, Prof. Agrégé de la Faculté de Medecine de Paris, etc., 1861.

The author describes, on the spermatic cord, a tubular organ formed by the rudiments of the Wolffian body, which continues to be developed till adult age. This he considers the origin of those tumours of the cords known as cysts, or as encysted hydroceles. The pamphlet is illustrated by a number of excellent engravings.

On the Sounds caused by the Circulation of the Blood. By ARTHUR LEARED, B.A., M.D., Dublin.

THE author considers that the heart's sounds are not in any way caused by the tension of the valves. His experiments have proved to him that "all sounds formed in connection with the circulation are produced by and in the blood itself, and their mechanism is virtually the same." Four conditions are necessary for the production of the perfect first sound:—1. Sufficient viscidity of the blood. 2. Sufficient force in the circulation. 3. Sufficient pressure upon the blood. 4. The absence of obstruction at the outlets of the heart. If a jet of fluid be projected into a reservoir of fluid, a sound is produced, and this sound is modified if the viscidity of the fluid be altered. Its intensity will vary according to the force used in its projection. The author concludes his thesis as follows:—"In short, vibration of valves or other structures, when in contact with blood, has no more to do with the sounds than the vibration of a door with the sound produced by the passage of wind through its keyhole. The sounds are, in the one case, due to rapid motions in the air itself, and, in the other to rapid motions in the blood itself."

Statistical Report of Patients treated in St. Thomas's Hospital from the Year 1857 *to* 1860. By the Registrars of the Hospital, WILLIAM ORD and W. H. STONE, 1858; J. ALLINGHAM, HENRY GERVIS, 1860. Edited by W. H. STONE, M.B., Assistant-Physician to St. Thomas's Hospital.

THIS Report consists of two parts. The first part contains the following Tables:—I. A general statement of the number of patients admitted in the hospital; the number discharged well, relieved, unrelieved, and discharged for special reasons, with the average number resident daily throughout the year, mean residence in days, and the rate of mortality, which amounts to 7·96 per cent. II. Showing the results in the various cases of disease in each year separately. III. and IV. of ages and illnesses previous to admission. V. Causes of death in surgical diseases, after accidents and operations.

The second part contains the details of groups of cases exhibiting special interest, arranged in a tabular form. There is an analysis, with the symptoms and the results of treatment of 44 cases of chorea, 29 of delirium tremens, 28 of delirium tremens and alcoholismus, 26 of neuralgia, 34 of paraplegia, 3 of empyema, 47 of plumbism, 14 of hematemesis, 12 of hepatic disease, 32 of icterus, 4 of peritonitis, 11 of strangulated hernia, 23 of anasarca post scarlatinam. Next follow four tables of

venereal diseases and one of erysipelas, containing 29 cases. Fever cases are grouped in three tables:—I. Showing 11 cases of typhus treated during 1858. Of these 2 were fatal, and 6 cases during 1859, of which 1 was fatal. II. 25 cases of typhoid during 1858, of which 5 were fatal. 32 cases of typhoid during 1859, of which only 4 were fatal. III. 9 cases of remittent and relapsing fever, of which 1 was fatal. Total, 83 cases of fever, 13 of which were fatal, or under 16 per cent.

Tables follow which give the results of injuries and lists of operations and fractures, with cases of lithotomy and excisions of joints are also given. The Report concludes with "Further Details concerning Operations" during the year 1858.

A Report of this kind should be furnished annually by every hospital and every public medical charity in the kingdom.

A Practical Treatise on the Ophthalmoscope, being the Essay for which the Jacksonian Prize, in the year 1859, *was awarded by the Royal College of Surgeons of England.* By J. W. Hulke, F.R.C.S., Assistant-Surgeon to King's College Hospital, &c.—1861. pp. 70.

To render the prize essay of more general utility, the author prefaces his book with a succinct account of the theory of the ophthalmoscope, and with a description of the various instruments at present in use. He then proceeds to give a brief outline of the appearances presented by the healthy ocular structures, and he analyses the theories advanced to account for the phenomena observed in the retinal circulation. After alluding to the morbid appearances presented by the cornea, lens, and vitreous humour, Mr. Hulke describes the deep changes accompanying coloboma in its different varieties, and refers to the occasional abnormal position of the optic disc, as observed by Desmarres and V. Græfe. The gradual and abrupt excavation of the optic disc, and their relative pathological importance, are next discussed, and allusion is made to the causes of unnatural elevation of that part. Anæmia of the optic disc next claims attention. The author believes that he has met with a case of embolus of the retinal artery. In contrast with these, true atrophy of the disc is quoted. The morbid anatomy and diagnosis of retinitis are next passed in review, and then the author quotes the appearances presented by a number of cases of retinal hemorrhage that have come under his notice. Detached retina, and the errors incident to its diagnosis, are illustrated. The author concludes this chapter with an analysis of the intra-ocular changes in kidney disease, as described by various German writers, of whom he appends a

list. Diseases of the choroid are similarly discussed with those of the retina, the pathology and appearances of inflammation of that tunic and of posterior staphyloma being pretty fully surveyed, and the description of the latter illustrated with cases and dissections. A summary is then given of the phenomena of glaucoma. The author ends his work with descriptions of intra-ocular cancer, tubercle, and entozoa. The book is illustrated with a series of beautiful chromo-lithographs and with many of finely finished engravings.

Observations on Progressive Muscular Atrophy. By E. Symes Thompson, M.D., Assistant-Physician to King's College Hospital, &c.—1861. pp. 17.

This paper is a reprint from the Transactions of the Medical Society of London. The author quotes the particulars of four cases that have come under his observation, and quotes others from the practice of Dr. Wetzlar. In discussing the origin of the disease, the author disposes of, by exclusion, the spinal cord, the anterior nerve roots, and the arteries, and concludes that the affection is primarily a muscular one. He then reviews the difficulties attendant on its diagnosis, alluding particularly to metallic poisoning and partial infantile paralysis, and ends by advocating the use of Faradization and a general tonic treatment.

General and Descriptive Anatomy of the Domestic Animals. By John Gamgee, Principal, and James Law, Professor, in the new Veterinary College, Edinburgh.—1861.

This work begins with a succinct history of the structure and functions of the animal tissues deduced from the most recent sources, British and foreign. It then gives a detailed account of the osseous system, as found in the cow, horse, dog, &c. The book is intended for the use of students, and is abundantly illustrated with woodcuts.

Archiv für die Holländischen Beiträge zur Natur in Heilkunde. Band III., Heft I.—1861.

The present number of this journal contains, among much other interesting matter, two papers, by I van Deen, on the formation of sugar from glycerine in the animal economy. The author details the arguments which justify the recognition of glycerine as an alcohol, referring to the discovery of the acid of the series by Pasteur, and to the observation of Berthelot, that its aldehyde could be produced by fermentation with albuminous matters. His own researches corroborate the conclusion of

Lehmann that this last is identical with Bernard's glycogen. He argues that glycerine is converted into sugar in the economy. In the first part of his treatise, he shows how sugar may be formed out of glycerine externally to the body, the agents employed being the constant stream and nitric acid, the results with the latter being very striking. In a second part he traces the transition of glycerine into glycogen, sugar, &c., in the economy, and especially in the liver. He fed dogs, that had been previously starved for several days, on glycerine and water, and found an abundance of glycogen in the liver, the analyses of other portions of the abdominal viscera tending to show that it must have been formed *in situ*. Thirdly, he shows how free glycerine may reach the liver. He assumes, from the different phases of fat deposition and resorption, that glycerine must always be present in the blood, and shows how it may originate independently of the fats present in the system. The presence of fat in the liver does not suffice to cause the formation of glycogen, because the fat must be split into glycerine and fatty acid. The condition for this is supplied by the formation of bile, which latter requires the presence of albuminous bodies, as the derivatives, glycine and taurine, appear simultaneously. Hence he concludes that there is a relation between glycerine, glycogen, sugar, and fatty acids, and between these and bile. The present number further contains a paper vindicating the individuality of roseola epidemica, and describing its course. It also contains a contribution by Brondegeest, illustrating the use of the sphygmograph in cardiac disease, and a paper by Buys Ballot, on the direction and force of winds.

Die Entwicklung der Adergefleckte. Von D. Jul. Kollmann. —1861. pp. 40.

Whilst attending more particularly to the development of the choroid plexuses, the author also gives a sketch of that of the brain during the earlier months of fœtal existence. After giving a slight description of the disposition of the cerebral circulation in the mature fœtus, the author describes the cerebral development between the sixth and eighth weeks, insisting that the cerebral hemispheres are not, as Luscka has said, lamellæ that are developed backwards and inwards, but capsules with only one minute aperture at their posterior part. The choroid plexuses of the lateral ventricles are already developed, whilst a curtain of pia mater, which hangs vertically downwards and is reflected over the optic thalami, communicates with them through the apertures above referred to. The falx next splits this curtain of pia mater into two layers. In the fourth month

only are the velum interpositum and the plexuses of the third and fourth ventricles developed, whilst the venæ magnæ Galeni are not formed earlier than the fifth month of intra-uterine life. Thus the choroid plexuses of the lateral ventricles are the earliest formed of the cerebral plexuses. The pamphlet is illustrated with five photographic engravings.

Over de Werking der Musculi Intercostales. Door Antonie Hendrik Schoemaker.—1859. pp. 76.

This pamphlet is a prize essay read at the University of Utrecht. The author divides his essay into two parts In the first he gives a historical and critical review of the theories advanced by physiologists touching the action of the intercostal muscles, from Galen down to the present day. He divides this review into two portions, that preceding 1842, in which he especially refers to Senac, Haller, and Hamberger, and that subsequent to 1842, including Majendie, Donders, Henle, Budge, &c. In the second part, after a brief description of the anatomy of the thoracic walls, the author experimentally determines the position of the axis around which the rib revolves in its joint to the vertebræ, first when detached, and then when connected with the sternum. This he found to go through the neck of the rib from behind, externally and superiorly, in the direction forward, inwards and downwards. The point of entrance lies immediately behind the costo-transverse articulation. The inclination of the axis of the eighth rib is almost parallel with the horizon; thence upwards to the first and downwards it becomes more and more vertical. This axis is nearly constant, whether the rib be connected with the sternum or not. The author then analyses the movements of the thoracic and abdominal respiration respectively. Passing finally to the action of the intercostal muscles, he concludes that the external ones raise the ribs in thoracic inspiration, and that under certain conditions the internal may assist their action. The intercartilaginous muscles are inspiratory. The internal intercostals drag the ribs downwards, and narrow the intercostal spaces. They are thoracic expiratory muscles, but assist in abdominal inspiration.

Het Lichtbrekend Stelsel van het Menschelijk Oog, in gezonden in Ziekelijkin Toestand. Door F. C. Donders. pp. 43.

In the present paper Professor Donders describes the different methods employed at various times to estimate the curvature of the cornea, and then gives the results of his own measurements both on healthy and on diseased eyes. He employed the ophthalmometer of Helmholtz, but, instead oi calculating

back from the angle of deviation of the glass-plate required to give the two corneal images a certain position, he determines empirically what number of degrees pertains to certain magnitudes. With this object, he places a silvered plate three millimetres high, and pierced transversely with lines one-tenth of a millimetre asunder, immediately in front of the two revolving plates of the ophthalmometer. When the plates are parallel, none of the lines overlap, but when at an angle to each other, inasmuch as the corneal image becomes double, a certain number of the lines become intensified, and thence the angle can be calculated back. This method he applied to the healthy cornea, and also to emmetropia, myopia, and hypermetropia. His results are embodied in a series of tables.

Onderzoekingen betrekkelijk de kimstmatige Verwijding van den Oogappel. A. W. KUYPER.—1859. pp. 62.

THE author starts by discussing the influence of the different nerves on the movements of the iris. He remarks that the indalation of chloroform increases the dilatation of the pupil induced by the sulphate of atropine. When the dilating power of atropine is at its maximum, irritation of the sympathetic further dilates the pupil. Diminution in the blood-pressure of the arteries of the iris has no influence on the pupil. Digitaline increased the diameter of the vessels of the iris. When the sympathetic was then irritated, these vessels ceased to be visible. Passing to the mode of action of mydriatics in general, he argues in favour of their absorption into the aqueous humour, and discusses their effect on accommodation, on the pressure of the humours of the eye, and on the muscle of Brücke. He then tests the value of all the reputed mydriatics, and concludes that the alcoholic extract of stramonium is as powerful as that of belladonna, and that hyoscyamus stands next to them. He concludes by laying down some general principles on the preparation and selection of this class of remedies.

ARCHIVES

OF

MEDICINE.

Part I.

CLINICAL OBSERVATIONS.

ON OPHTHALMIA.

By Jeffery A. Marston, M.D., Assistant-Surgeon Royal Artillery.

Plates XII and XIII.

THE subject of ophthalmia, as it prevails in the army, is brought before the profession because it is conceived that erroneous impressions are very generally entertained with reference to one, at least, of its most common forms.

While some would seem to include all conjunctival disease under the one head—conjunctivitis—and would explain the different appearances and morbid states, by a reference to the different degrees of inflammatory phenomena existing in different cases, tracing the phases of the disease from the simpler elements of the most trifling vascular reaction upwards, to the more intense purulent inflammation of the membrane; there are others who perceive in the ophthalmia of armies an altogether specific affection. These latter regard the conjunctivitis ordinarily attacking the soldier as a disease *sui generis*, having a special etiology, running through a different course, and marked by such symptoms and pathology as entitle it to be ranked separate and distinct from the conjunctival diseases ordinarily prevailing in civil life.

Military ophthalmia, uncommon in England, but only too prevalent abroad, is hardly ever seen at the various ophthalmic institutions, at a period corresponding with its primary or early stages. The cases, such as present themselves at ophthalmic hospitals, are suffering from advanced forms of the malady, when any analytical examination into the nature of the changes and progress of the disease in the elemental structure would be futile, both on account of the extensive

alterations in the palpebral conjunctiva, as well as the various other morbid lesions which have arisen.*

To the report of the "Congrès d'Ophthalmologie de Bruxelles, 1858," I am indebted more particularly for my first acquaintance with the true import of the phenomena, which I had long observed in the disease in question. It will be necessary to premise a succinct account of the histological anatomy of the palpebræ to render the succeeding remarks intelligible. Besides the loose layers of skin extending over the eyelids; the pale muscular fibres of the orbicularis; the tarsal cartilages, with their Meibomian glands; and their fibrous suspensory ligament, obtained from and continuous with the periosteum of the orbit; we have the lining membrane, or conjunctiva. This belongs to the class of membranes having a laminated pavement epithelium. The free surface is covered with a layer of epithelium of flattened polygonal scaly appearance. The cells are very clear, large, $\frac{1}{500}$, $\frac{1}{1500}$, to $\frac{1}{2000}$ inch in diameter, with distinct oval nuclei, and refracting nucleoli; the long diameter of the cells of this free surface is, for the most part, parallel with the long diameter of the lid. Their edges appearing to be not only apposed, but even overlapping one another, forming a laminated pavement. As we pass deeper, the cells, still polygonal, are smaller, and tend to the spheroidal form, to which configuration they conform in the deeper layers. The cells in immediate contact with the papillary structure, have, more or less, a vertical arrangement, are much smaller, and of the character of enlarged nuclei. They lie embedded together, and capping the sides and apices of the papillary structures, the wavy, undulating ridges of which they follow and serve to map out. These cells are supported by a layer of submucous areolar tissue, analogous to that of the tunica nervea of mucous membrane, or the dermis of the skin. This investment, in which the vessels and nerves ramify, is composed of an indistinctly fibrillated substance, commingled with yellow fibre, in sparing proportion, and disposed in coarse areolæ. The superficial portion of this layer differs from the deeper only in the closer arrangement of the connective tissue, the smaller size of the areolæ, and the prolongation of such fibrillated tissue into conical, rounded, or oval elevations,—the papillæ.

The tissue in which this species of ophthalmia runs its pathological course is a connective tissue.

* Mr. Dixon, in his Contribution to Holmes' System of Surgery, upon Ophthalmic disease, does not allude to the premonitory and pre-existing vesicular state of the lids, as the most fruitful source of granular lids.

By a connective tissue I understand "a number of cells retaining their nuclei, round each, or each group of which, a quantity of tissue material (indifferent tissue) is collected, the quality of which, as a tissue, depends upon the consistence and constitution of this intercellular material;" the whole corresponding with the endo- and peri-plasm of Huxley; the masses of *germinal matter* and surrounding *formed material,* of Beale; or the cell and cell-territories of Virchow. The latter physiologist and pathologist teaches, that "the nutrition of these tissues, whose function is a mechanical one, depends upon the selecting and organizing properties of the cells; their growth by a due increase in number, their repair by more abundant reproduction." The papillæ resemble the similar structures of the cutis. Upon the tarsal portion of the membrane the papillæ generally, have a simple conformation, are small, and more or less cylindrical or conical. At the retro-tarsal reflection however, the conjunctival membrane not only becomes much thicker, from containing a larger amount of connective tissue, but is at the same time looser in its texture and connexion with surrounding parts, to allow of the different movements entailed upon this part of the lid. Here the papillæ are much more compound in structure. They are larger (as much as $\frac{1}{10}'''$ long) and assume a warty or fungiform character (from the production of secondary papillæ, closely placed and conical,) resembling indeed the fungiform papillæ of the tongue.

The papillary layer is developed from the fibrillated connective tissue of the corium, and is prolonged into more or less conical or columnar projections. The connective tissue can only be traced into the bases of the papillæ, whose conical apices appear almost entirely composed of a homogeneous-looking substance and small spheroidal epithelial cells. These papillæ have an arrangement in rows, parallel to the long axis of the lid. I have been unable by any reagent to develope a basement membrane, supporting the epithelium. The whole of the submucous tissue is a highly vascular nervous structure. The course of the nerves is easily determined in sections treated by soda.

In the retro-tarsal region of both lids there exist a few compound acinose glands, viz., those so well described by the two Kraüses. They are best seen in that portion of the connective tissue layer immediately subjacent to the epithelium and papillæ, where the areolated tissue is laxer and less closely attached to the subjacent textures. By pinning this part of the membrane to a cork, and permitting it to dry, or by previously hardening it in chromic acid, vertical and horizontal

sections can be easily made, by which the minute structure of the glands can be accurately determined. The application of glycerine and acetic acid facilitates their examination. It is curious that in some eyes these structures are found with great difficulty, while in others it is a comparatively facile proceeding. If a section has been cut from a part previously hardened in alcohol, great care must be taken in teazing out the preparation, so as not to put it too much upon the stretch, for this, (and the subsequent addition of water,) renders the tissue very opaque. In diseased lids these glands are very easily discovered, with the aid of a lens, on account of their greater size and development, indicating their exact site. They are particularly liable to hypertrophy in granular disease of the lids; indeed I shall have reasons to adduce to prove that in certain forms of "vesicular" lids, these organs become affected.

They conform to the racemose or conglobate type, are but few in number, sparsely shed in the connective tissue layer, and open by small ducts upon the free surface of the lids. These little mucous glandular bodies range from $\frac{1}{5}$ to $\frac{1}{25}'''$ in size.

The small flask-shaped open follicles discovered in the ocular conjunctiva by Manz, and subsequently by Stromeyer, in the conjunctiva of the human eye, near the cornea, do not exist, as far as my observation goes, in the palpebral portion of the membrane. It is interesting that these little bodies exist at the exact site at which the so-called phlyctenulæ of strumous conjunctivitis make their appearance.

In addition to these little compound acinose glands of Kraüse, others have been described;—a system of small saccular closed follicles or mucous crypts, both by Van Roosbröeck and Bendz. As these observers consider them to be the special seat of important pathological changes by which vesicles are produced, we must advert to them.

Van Roosbröeck published his researches into the causes and pathology of purulent ophthalmia, many years ago, in which he pointed out the important changes ensuing in certain glandular and closed mucous follicles, the existence of which in very great numbers, he declared was part of the normal structure of the palpebral portion of the conjunctiva. Bendz, whose observations are of the most valuable and important character, states "that the little glandular bodies are closed sacs (filled with cells, nuclear particles and fluid,) hardly appreciable to the eye, but apparent to the microscope: round or ovoid, of a whitish colour, surrounded by an amorphous opaline membrane, and seated in the vascular corium." He describes, indeed, two kinds of these glands—the simple and agminate,

analogous to the intestinal glands. He speaks of the agminate variety being pretty constantly present, as a patch near to the external canthus. He decided, too, that these follicular organs were limited to the palpebral conjunctiva. The small vesicular looking bodies represented in the accompanying Plate, and which, as we shall see, play so important a part in soldier's ophthalmia, Bendz conceives to be neither more nor less than these bodies affected with a specific morbid process and deposit. Recognising thoroughly the specific characters of military ophthalmia, he proposes to call the little granular bodies *glandular*, to distinguish them from the ordinary *papillary* granulations.

If we minutely inspect the lining membrane of the eyelids of the men of a regiment, we shall observe, (certainly in the colonies,) that some of them present small raised bodies, like Sudamina or Herpes. In one man there will be but two or three such, and these very transparent, and limited to the outer canthus; in another, the conjunctiva will appear as it were the seat of a vesicular disease, such as "Herpes," so studded will be the membrane with these bodies.

Müller and Eble directed the attention of the profession to this vesicular-looking disease years ago.

From repeated examinations I am not convinced that the follicular organs described by Bendz have a constant physiological existence.*

By removing one of the vesicular-looking bodies, teazing it out, and using a low power (one inch,) we observe a round or oval-shaped granular mass, dark-looking and opaque in the centre, passing off into a lighter shade towards the periphery, where the colour almost abruptly fades into that of the neighbouring part of the fibrillated-looking stroma, upon which the

* As early as 1859 I thought that I had discovered small follicular bodies in the normal conjunctiva. Failing often afterwards to detect them in healthy lids; observing how morbid products mimicked their characters, and their disproportionately large number in diseased lids, I have thought it best to adopt the conclusions in the text. My friend Dr. Frank was kind enough to inquire of Professor Kölliker, when he visited Fort Pitt, whether he had detected these physiological organs in the conjunctiva, but that distinguished histologist denied their existence, in common with other observers. Kraüse, junior, quite recently, has come to an affirmative conclusion as to their presence. He prepares his specimens by steeping the lids in vinegar for three days, by which the epithelium is removed. The very minute whitish prominences which then appear, he removes by scissors,—treats with glycerine,—and examines. The subsequent addition of liq. potassæ brings out the reticula. Henlè, in a recent paper upon conglobate glands, has also described organs, under the name of trachomatous glands, as normal structures in the eyelids of animals. An illustration, at the end of this paper, represents a happy section, prepared in the above manner. Plate xiii, fig. 5.

vesicle appears, as a little ganglion or knot. By placing the object under a quarter inch, we can trace exactly the limits and character of the new products. This little knot will be found to correspond to one of the interstices, or minute areolæ, naturally existing between the connective tissue elements. In this vacuole or mesh, we have an outgrowth of new cells,—the cells, nuclei, and granules of all sizes, being massed together in luxuriant growth. The number and mutual aggregation of these neoplasms give, in a coarse section, an opaque appearance, from transmitting the light imperfectly. Around this, and further from the focus of the disease, we observe the white wavy tissue, granular-looking, brcad, ill-defined, and with indistinct edges towards the centre of the growth. Now this little nest of cell-growth so defined, exactly assimilates to a follicle, filled with granular and cell contents, and is really nearly identical in appearance and constitution with the vesicular-looking condition which the mucous follicles of the colon assume in incipient dysenteric disease.

These sago grains (as they have been called,) when latent and most vesicular in appearance, are nevertheless unlike the vesicles of Herpes, Scabies, or Sudamina, inasmuch as they cannot be emptied. However liquid their contents may appear, no pricking of them causes their collapse.

When such an one is removed and examined, while still fresh, it is evidently succulent, the little celloid and nuclear particles, making up in them the small knot or vesicle, move upon one another and alter their position (within certain limits of course,) by pressure, showing the presence of a certain amount of fluid.

When these sago grain granules have passed through their vesicular and succulent stage, and become only part and parcel of that granular state, common to all the textures of the conjunctiva at a late or chronic stage of the disorder, their progress cannot be easily traced, from the fact that we are not sure whether we have an advanced stage of the sago grain granule, or a fleshy outgrowth of the papillary and other parts of the connective tissue structures. Often, however, the vesicles are sparsely shed from the first, and run their whole course to a firm fleshy condition, with little or no affection of neighbouring parts. I have removed them in such a condition, and they range themselves under two heads.

1st. Those in which the cells remain large, unduly round, and numerous in amount, appearing to be increasing rapidly, with numerous globular nuclei. The cells of the epithelial layer about such, have departed from the normal character, and

bear evidence of rapid local increase;—are spheroidal, with granular centres, like exudation cells, and as we approach the free surface possess the characters of pus. There is an entire absence or paucity of fusiform cells in this variety, and the granules, as a whole, form a large exuberant fungous growth, succulent in appearance, and rapidly degenerating into muco-pus at the surface.

In the second variety the fleshy granule may appear almost vesicular in the centre, while it is dense, firm, and of a dull red at the circumference. These have fewer spheroidal nuclei and cells of a small size, in the central portion, corresponding with the less opaque part; while at the circumference the cells have become fusiform, or show a tendency to become oval and elongated at the extremities, conforming in character to the connective tissue layer, into which they doubtless pass.

As far as I can judge, my observations and examinations would lead me to suppose that this forms the stage of arrest or cure. This would appear to accrue from the development and contraction of the fusiform cells (while the more active and succulent nuclear particles remain as such, ceasing to generate unduly, or become absorbed). Minute vessels can be easily traced in both varieties, but the first yields far the most blood on section, judged by the number of blood globules in the field; while the latter yields fewer and more distinctly traced vessels. Indeed, a certain vascularity, around the margin and in the neighbourhood of the outgrowth, can be seen with the naked eye, and more easily traced with a lens, in the fleshy sago grains undergoing the process of arrest and cure.

When numerous little crypts of this cell formation and nuclear aggregation existed, divided and intersected by the penetration of connective tissue, the whole had the appearance exactly of a Peyerian follicle, upon a miniature scale. When the sago grain granulations disappear in the more advanced stages of the affection,—becoming merged in the generally hypertrophied condition of the inner aspect of the lids,—the disease may remain in abeyance, with an occasional recurrence of sparsely shed vesicles, which remain for some time as such,—become absorbed,—or run through a slower grade of morphosis, according to the continuance of vascular excitement or not. The vesicular bodies could hardly reappear if they had their seat in a physiological structure, because that would have been destroyed by the pathological changes incidental to the progress of the metamorphosis going on in it. It was the observation of the exhaustion of the vesicular bodies, and their reappearance

in certain cases, which led me first to doubt the existence of these glandular bodies as normal anatomical organs.

Their reappearance is traced thus:—In the interior of a chronic granulation, the central cells begin to grow, multiply, become vesicular, succulent, looser in arrangement, and mixed with granular matter; while the cells upon the periphery retain their character of fusiform cells.

Microscopic observations would induce me to think, that in the immediate neighbourhood of the acinose glands, described by Kraüse, this abnormally active germination has its origin. These glands exist particularly at the retro-tarsal folds of the upper and lower lids, and, as has been already stated, may be found near the outer canthi of the palpebræ. Now it is exactly in these situations that we find the larger vesicles, or sago grain bodies, and upon two occasions in which I removed them, I discovered a part of the racemose structure of the gland, surrounded by much granular matter, nuclei, and celloid bodies. Of the *exact* relation of these new growths to the glands on the one hand, or the surrounding stroma upon the other, I would not speak with confidence. It is almost certain to my mind that Kraüse's glands do commonly undergo some changes in granular conjunctivitis, as they appear hypertrophied, and are far more easily found in morbid than healthy lids, yet it is still more certain that the disease may arise, and sago grain granulations exist in other structures than those of the gland tissue or its stroma.

Histology then has thrown very little *positive* light upon the nature and origin of the disease. It would appear that it commences in the deeper cell surface of the conjunctiva, immediately adjacent to the connective layer. That a rapidly germinating cell growth affects minute patches of the membrane, by which the delicate areolæ of the corium become filled with a new structure of succulent character. Whether these new growths arise directly from Virchow's cells of the connective tissue I cannot pretend to say, but I regard it as the most tenable theory.

Pathology and Symptoms.

1. *Vesicles.* Slight gumming of the lids.

2. *Vesicular congestion.*—Sight weak; lacrymation in a bright light; muco-purulent shreds on lower lids.

3. *Vesicular exudation.*—First stage of granular conjunctivitis, *i.e.*, the stage when it is readily observable, and most usually comes under treatment.

4. *Purulent Ophthalmia.*—Not common.

5. *Granular Conjunctivitis.*—Usually seen when the disease is endemic:—purulent ophthalmia when epidemic.

The vesicles appear as the *primary lesion, and are the very first products generated by the morbific agency.* That these are not the sequelæ of an inflammatory process,—but rather the powerful predisposing causes to, and modifying agents of, any inflammatory phenomena that may ensue, appears certain.

In the first stages the enlargement and permanence of the vesicles are the only evidence of the disease. On depressing the lower lids, they may be seen scattered like sudamina, over the conjunctival folds,—grouped around the canthi,—or studding the whole retro-tarsal region. In appearance they closely resemble saccular glandular bodies. They lie immediately beneath the epithelial layer, upon and in the connective tissue of the conjunctiva. These bodies are eminently chronic, and may remain an indefinite time, or be absorbed, to be succeeded by others, particularly if the subject of them remain exposed to the same influences as generated or fomented the disease,—a circumstance which is unfortunately but too frequently the case with soldiers.

When dying off, one often sees them larger, more scattered, and though still transparent, of a brownish hue, with one or more small varicose vessels running across them. The upper lid is frequently free, or affected in a less degree,—no congestion, lachrymation, nor pain, indicating their presence. Perhaps when attention is directed to the point, gumming of the lids at night, and occasional itching, may be made out. There may be, and generally is, an absence of all subjective symptoms, and it requires a minute inspection of the internal aspect of the lids to discover the vesicles.

The presence of these vesicles in a great number of soldiers without attracting any attention, or producing any morbid symptoms, and the contagious nature of the disease, are a sufficient explanation of the great difficulty attending the extirpation of ophthalmia when present among troops.

The disease frequently stops at this stage, especially when the conditions favourable to its development are wanting. Out of 861 convicts examined at Gibraltar there were—

Vesicles	441
Granulations . . .	46

The remaining 374 were quite sound, excepting those in hospital (about 45), who were not examined.

Vesicular congestion is very common, and may be induced by friction, dust, cold, wind, &c.

The conjunctival congestion gives pricking pains, (or more

likely sandy irritation,) with weakness of sight in bright light, muco-purulent shreds on lower lids, and no great change in the vesicles themselves, (though they of course share the general congestion of the conjunctival mucous membrane).

Rest, in the shade; fomentations, cooling lotions, and a purge soon restore the eye; the vesicles remaining as before. In this quasi-inflamed state, a little winking in the sun, a gummy state of the eyelids in the morning, a collection of altered secretion,—forming in short a slight blenorrhagia,—occur. Let such a case be exposed to a long march, to much exposure to sun, dust, alternations of temperature, a debauch, guard mounting, night dews,—and an active stage ensues, a congestion of the palpebral conjunctiva. Effusion of plasma from the vessels, alterations of colour, opalinity, and alterations in the size and character of the contents of these sago grain granules, which, losing their pellucidity, become more and more opaque, red, and at last fleshy. At the same time the papillary bodies become affected and rapidly develope and degenerate upon the two lids—leading us to

Vesicular Exudation is the most important stage of granular conjunctivitis.

The watery bluish-red eye, the œdematous, half-closed blinking lids, and sniffling nose, plainly tell their tale of pain, intolerance of light, and inflammatory action in the lids; and now is the time that frequent inspections, with prompt and judicious treatment, will save the sight of many eyes, and months of wearing pain. There is no mistaking the disease. It is imprinted on the sufferer's face; depress his lower lids, and the palpebral conjunctiva starts into view, thickened, engorged with blood, and studded with numerous vesicles, passing through the successive phases of inflammatory action. They *become larger* by increased local growth, (hyperplasia) and seem more numerous, as those more deeply seated swell out and press to the surface;—small bloodvessels crowd around their bases, and creep over their surface, or penetrate into their interior. The effused fluid becomes pearly and pink from commencing organization, and finally the vesicle loses all specific character, and shows itself a true granulation. Papillary granulations also form in the lower lid, and the tarsal bodies of the upper lids are reddened and bristling with very fine papillary granulations, increasing in number and size, towards the canthi.

Purulent Ophthalmia.—This is not very common, when the disease does not prevail in an epidemic form. Cases, however, sporadically occur. Of course the disorder may advance at once

from the initiative vesicular stage to the purulent, without passing through any other (at least observed) stage of the disease, if the exciting causes act with sufficient intensity, and the conjunctival membrane in an equal degree responds to the morbid agencies. In the course of a few hours, a case of congested vesicular lids may pass into an acute purulent ophthalmia, as I have myself witnessed. There is great photophobia, the eyelids are œdematous; their scarcely apposed edges stick together, with morbid secretion. As soon as the lids are separated, a gush of tears and muco-pus flows from beneath them. The lids, partly from their great weight, and partly from spasmodic action of the orbicular muscle, cannot at all, or with difficulty, be separated sufficiently to expose the ocular membrane. The ball of the eye is involuntarily rolled upwards and inwards, concealing the cornea beneath the upper lid.

The ocular conjunctiva is swollen and œdematous (chemosis), and what can be seen of the cornea appears as a deeply depressed circle within the raised roll of conjunctiva. There is intense vascularity, the conjunctiva being of a scarlet hue. If the chemosed membrane be seized with forceps, drawn out, and strips cut out of it, the exudation escapes with difficulty, owing to its consistence, and in a few hours the chemotic swelling will appear as bad as ever, even if it subside after the incisions. In this condition the tendency is directly to sloughing of the cornea, or rapidly extending ulceration, escape of the aqueous humour, staphyloma iridis, with dense cicatritial tissue, keratitis, albugo, or some opacity of the cornea. In passing, it may be remarked, that if strong caustics be avoided, and copious local depletions be employed at first, these opacities clear away wonderfully in time; even the worst looking of them greatly improve, from gradual absorption of the circumferential opacities around a cicatrized ulcer,—for much of the opacity is the result of a diffused inflammation and infiltration of the superficial layers of the cornea, or mere loss of transparency, from stretching and deranging that parallelism existing in the lamellæ of the cornea proper, the maintenance of which is essential to its transparency.

As the disease recedes, normal epithelial cells begin to cover the hypertrophied conjunctiva and its papillæ. As cure becomes established, the cells which have been so rapidly produced, during the progress of the disease, assume the spindle-shaped form, become fibrous in character and shrink;—while the projecting villi become more and more smoothed down, the vascularity diminishes rapidly, and the lids appear smooth, and of a dull red aspect, rarely, if ever, perfectly returning to

the normally pale state, (if the patient remain in the same climate,) and prone to take on active local progress upon the slightest irritation. They cease at last to cause corneal disease from attrition of that structure, and a certain feebleness of sight only may remain.

This state of things does not obtain in the gonorrhœal purulent ophthalmia, a disease if anything more acute, and as much marked by all the morbid tendencies to corneal implication as the military purulent form, yet more rarely treated, and tending to a perfect cure, without the hypertrophied state of the conjunctival membrane remaining,—as a granulated, dull red mucous membrane,—such as it invariably does in the latter.

I state this as the result of observations obtained from treating cases of the two diseases in officers and men, at the same periods. In gonorrhœal ophthalmia the tendency is to the occurrence of a crescentric ulcer affecting the cornea, near its lower edge, while intense military ophthalmia gives rise, (a hazy state preceding or not,) to sloughing of that membrane.

Granular conjunctivitis almost invariably affects both eyes, either from the first, or during treatment. This is the result of the acute forms, such as the last, or arises in those who have passed through the stages described in a less acute degree. The whole of the structures become involved, both papillary, connective tissue, and glandular. The eyelids are œdematous, the patient walking about with them closed entirely, or but slightly open. They stick together with the morbid secretion from both the Meibomian and Kraüse's glands, with all the results and concomitant symptoms attending the hypertrophied and granulated condition of the membrane, modified according to the degree of vascularity that may be present. The now granular surface, rising up the epithelial structures, becomes the source of a morbid excretion, aqueous, muco-purulent, or purulent. The epithelial cells cease to cover the papillary layer, spheroidal ones taking their place, and becoming rapidly exuviated by the development of the deeper granulation cells. The upper lids become covered with soft succulent strawberry-like projections, massed together, especially in the neighbourhood of the angles, and retro-tarsal fold, where Kraüse's glands exist, while in the lower lid, the granulations are more regular, villous, pilose, and less spongy. Such granulations resemble those of an ordinary granulating wound; the superficial ones passing off as pus, while the others remain crowded together, one upon the other. The sense of the presence of foreign bodies is always present. Photophobia, the contracted brow, and confirmed ophthalmic aspect, become typically marked.

I have observed that the features tend to waste, disproportionately to the remainder of the body. The nose (particularly in those who have long ones), shows this wasting, and the patients themselves, from the disease and confinement combined, assume a chloro-anæmic aspect, suffer from dyspepsia, and become pot-bellied;—the cornea gets implicated, keratitis, pannus, or ulceration ensues, and one may perceive occasionally the posterior elastic membrane of the cornea, projecting as a hernial protrusion through the ulcer, yielding before the aqueous humour and threatening momentary rupture, which, however, it generally escapes.

As the disease assumes a more chronic form, the discharge diminishes, and is observed as a narrow film, along the palpebral sinus. The conjunctiva assumes a dense fleshy aspect, of a dull brick red, or brownish hue, in which state it long remains. Upon depressing the lids, the parallel arrangement of the granulations becomes obvious, little furrows or lines of separation appearing along the long border of the tarsal cartilage between the lines of granulations.

As these granulations diminish in number, size, and density, the deeper cells assume the spindle-shaped form, whilst absorption of the liquid and semi-organized products rapidly advances. During such retrocession of the symptoms the sago grain bodies may reappear and disappear. However protracted the case, the disease makes in the end wonderful improvement, and the lids, in very many cases, return to a nearly, (though hardly ever a perfectly) normal state; a few vesicles and granules remaining to mark the disease, while the eye is very prone to fresh inflammation and relapse. If caustics have been freely applied, or the fleshy granulations pass off by a molecular disintegration, we find minute depressed cicatrices, with little white lines running from these,—(stellate cicatrices).

Diagnosis.—Undoubtedly not all military ophthalmia is of the vesicular form. A neglected catarrhal ophthalmia may go on to granular lids; and the strumous variety of conjunctivitis, which is very common in the army, tends to a purulent ophthalmia and granular lids. Indeed, ordinary conjunctivitis, in delicate subjects, frequently produces a granular state of the palpebræ and chronic ophthalmia, without having ever been preceded or accompanied by the vesicular granulation. My own experience would lead me to infer that the catarrhal form rarely becomes purulent, and seldom affects the lids, and that granular lids are the products of either the strumous or vesicular varieties.

The vesicular granulations, which are the primary stage

of the disease, are absolutely characteristic. The diagnosis will hinge upon the following considerations:—that the inflammatory reaction of the conjunctiva follows their presence and development; that such vesicles may exist for a long time alone without any other objective symptom; that the subjective symptoms are very slight, and are dependent upon the amount of inflammatory reaction, and not upon the presence of the vesicles. In the catarrhal disease, the subjective symptoms are early evident, the ocular conjunctiva is attacked as well as the palpebral, the vesicular granulations are not present, at least in the early stage, and may be absent altogether, or only appear at a later date, when the conjunctival inflammation has existed for some period; that if they appear, they are symptomatic of such conjunctival disease, constituting a secondary, inconstant, and fugitive phenomenon, and never developing into confirmed fleshy granulations, or becoming chronic. That the catarrhal disease arises spontaneously during the action of some catarrhal cause, as a special atmospheric constitution. That it is not (*per se*) contagious, nor infectious, nor limited to certain corps or bodies of men; while the military form attacks a great many men, a single regiment, troop, or a particular room;—affects the lids, begins, and often for long continues, with vesicles;—is essentially chronic, going on to fleshy granulations, and does not cause an injected globe, but is limited (primarily at least) to the lids.

Prevalence of the Disease.—The scourge that ophthalmia proves to troops serving abroad, and to bodies of men, gregarious in their habits and mode of life, is only too well known, and as far as the Mediterranean stations are concerned, may be seen by a glance at the following analytical tables.

I have to thank Mr. Nesbitt, late of Her Majesty's Convict Establishment at Gibraltar, and now Surgeon to the Wolverhampton Hospital, for the following tables. He has also placed at my disposal an admission and discharge book of all the cases of ophthalmia occurring among the convicts from 1846 to 1859, with copious details as to causes, symptoms, duration, and treatment in each case. I stand indebted to him, moreover, for furnishing me with the results of his very extensive experience and careful observations.

The establishment consists of a hulk—the "Euryalus"—well ventilated, clean, and with good washing tanks. A prison, on shore, built of wood—a long low building, four feet above the level of the sea, to which it is open upon the north-east aspect. The prison is well drained and ventilated in itself, but occasionally offensive from decomposing seaweed, and the

accumulation of ordure about the mouths of the drains from the south part of the town, which debouch in front of the building, and disgorge immense quantities of filth after the rains of the spring and fall of the year. On the land side, the prison is bounded by a lime wall, a few feet behind, and rising to some height above it. The building is two stories high, each story being divided, by a wide corridor, into rooms or classes, constructed to hold sixteen men each, with a water-closet and washing apparatus to each. The men were too closely packed, and, when the hammocks were hung, they touched one another. The hammocks are rolled up during the day, and placed upon a shelf in the class. In 1859, the old washing-places, with a liberal supply of water, were removed, and inclined wooden troughs substituted—sixteen men washing in the same filthy water, which was afterwards used for cleansing the floor. The convicts rise early, bathe constantly during the summer, are clean in their persons, well fed, and slightly worked. From the perfect regularity and forced temperance of their habits, they are remarkably free from syphilitic and epidemic disease, as a rule. Typhoid fever, intermittent, and cholera, have however appeared among them at different times.

The Garrison of Malta.

RETURN showing Ophthalmia for 10 years, 1850—1860.

Years ending 31st March.	Strength of Garrison (average)	No. of Ophthalmic cases admitted.	No. Invalided for Ophthalmia.	Ophthalmia to strength per 1,000.
1850	3171	203	5	64·017
1851	2917	223	30	76·44
1852	3196	268	7	83·86
1853	3157	218	4	67·79
1854	3803	285	22	74·93
1855	3213	222	10	69·09
1856	1741	133	5	76·28
1857	7239*	1486	22	205·27
1858	6160	958	73	155·5
1859	4899	534	58	108·96

The *expeditionary* force is not included in this return, no correct returns could be obtained from the Italian Legion.

* Caused by the arrival of nine regiments from the Crimea.

Nature of the Disease.

Etiology.—Bendz considers soldiers' ophthalmia a purely local affection, residing in the conjunctiva of the lids, and due to a peculiar contagious principle, of which we know not the nature nor vehicle; that the disease takes on a specific form, though somewhat variable, and by predilection attacks the mucous glands? of the palpebral conjunctiva, secondarily affecting the papillary bodies of the lids, spreading by contagion, and, most frequently, by miasmatic means (*i. e.*, infection through the air), more rarely by more immediate or direct ways. It does not appear capable of spontaneous development under the influence of ordinary atmospheric conditions. He terms the affection an "adéno conjunctivite des paupières," of a specific form, and believes that the primary action of the virus, or contagious principle, is upon his so-called vesicular glands.

The disease is endemic in Denmark, Belgium, and Ireland. It prevails also in Malta, as I have reason to know from personal observation, in addition to the ordinary catarrhal and strumous forms of conjunctivitis. The question arises at the outset—Can an intensified catarrhal ophthalmia give rise to the so-called vesicular granulations? It is, of course, extremely difficult to exclude the possibility of any given case of catarrhal ophthalmia not having been affected by a pre-existing sago-grain granulation in a slight degree, particularly as it is certain that an ordinary catarrhal conjunctivitis, arising in one the subject of the vesicular bodies, directly tends to assume the chronic form, and become purulent or granular.

If a pure catarrhal conjunctivitis does generate this peculiar affection of the lid, it must do so very rarely indeed, and under circumstances which are themselves powerful predisposing causes of the disease, viz., among men gregarious in their mode of life, and subject to the evils of overcrowding, infected air, and defective ablutions, &c., for it is very rare to find the disease generated among the officers, their families, and the women of a regiment, although they are subjected, equally with the men, to the catarrhal forms of the malady.

The injected and irritable state of the palpebral conjunctiva to which officers are liable from the prevalence of wind, dust, glare, &c., presents a very different disease from that induced by the same exciting causes among the men; the disease contracted by the former has, with rare exceptions, a different course, appearance, and is much more amenable to treatment. The lid of an officer affected by inflammation from these causes is much injected; the Meibomian ducts are here and there

filled with concreted secretion, and the epithelium appears raised into exceedingly minute prominences, very closely aggregated together, (the merest points) and never of the large size, and sparsely shed, semi-transparent, sago-grain granulation, observed among the men.

An officer, who kindly sketched some vesicular lids for me in August, 1860, was tempted to look into his own eye, and there, sure enough, were three or four vesicles at the outer canthus of either eyelid. My attention being called to the circumstance, I took the opportunity of examining all the officers' eyes, but they were perfectly healthy, with this exception.

The vesicles in this officer's lids remained quite latent until the spring of the present year, when, (after exposure to a moist wind and dust) he got catarrhal ophthalmia. The conjunctiva now took on the form common to soldiers; numerous bodies of a similar character were rapidly evolved, and he is now the subject of granular lids.*

Defective Hygiene.—There must have been some cause, or plurality of causes, operating in order that the first case, whenever and wherever it arose, should have made its appearance; and it would be going very far to deny that a similar combination of causes should not arise again, and generate the disease, irrespective of contagion. The disease seems to have some intimate connexion with miasmatic influences, and my own experience and observation would lead me to infer that it prevails with diseases incidental to bodies of men exposed to malarious and effluvial emanations. The convicts in Gibraltar, however, seemed to be tolerably free from diseases of an epidemic type. In Malta, on the contrary, the barracks in which ophthalmia appears, yield other disorders. Typhoid or enteric fever, gastric remittent, rheumatism, and certain forms of febrile dyspepsia are common at the same time, or at different periods of the year, and during different years in the very same barracks, which yield long lists of ophthalmic disease.

It must ever remain a difficult problem to solve, the question of the causation of the disease, because, when once generated, it is so liable to spread in a regiment; even in healthy localities, where men live together, the means of ablution and ventilation are necessarily somewhat limited; nevertheless, I have no doubt that the sago-grain granulation may arise *de novo*, from the operation of the self-same con-

* Qy. His military servant had the disease in a latent form.

ditions as obtain in miasmatic disease, using the latter term in the general sense.

Some facts lately furnished me by Staff Assistant-Surgeon Dr. Frank, (himself an expert histologist, and most trustworthy observer), have a direct bearing upon the generation of the disease from unhygienic influences.

"Stromeyer found in pigs living in an unhygienic state that such grey granulations were commonly present upon the lids: between the manner of whose living, &c., and that of some men, so many connecting links may be pointed out."

Stromeyer, (and some scientific men connected with him) conceived the idea of examining the conjunctiva of animals with the view of setting at rest the question of the presence of the closed mucous follicles described by Bendz. They examined 1,000 eyes of different animals, domestic and wild. Stromeyer found that no physiological organs corresponding with the sago-grain granulation existed in pigs well tended: to wit, in pigs having "a bedroom and parlour," and clean litters; he therefore infers that they are pathological or neoplastic formations.

Stromeyer concludes that Bendz, (who had the assistance of his brother, the anatomist at Copenhagen) must have examined conjunctivæ at a time when granular ophthalmia was epidemic in that city, and that his so-called follicles were in reality not physiological but pathological formations. Stromeyer's observations would seem to prove *that given certain unhygienic conditions, this kind of ophthalmia is almost sure to follow among domestic animals.*

Dr. Frank goes on to say, "I obtained some pigs' eyes the other day, and was pleased to find that they were pigs of the lower orders. The lids were in a condition of vesicular granulation."

I have myself examined the lids of some sheep, pigs, and goats, but have not been fortunate enough to find these vesicular bodies in any instance.*

As an illustration of the generation of the vesicular lids from the operation of natural causes, irrespective of contagion, I may mention the following:—An officer, with a family of eight children, occupied a large house in Malta; six of the children slept in rooms leading one from the other, with the female domestics. The day nursery was also occupied at night. The ventilation and lighting were bad, and there was effluvia

* The etiological causes, which Stromeyer conceives to be productive of the disease, do not obtain here, for all the domestic animals live almost entirely in the open air. (Malta).

from a drain in the kitchen. These six children had vesicular lids during the spring of 1860. The seventh child slept separately, and the remaining one was an infant. The six children, I learnt, were bathed in the same water. Attention to cleanliness, ventilation, &c., and the removal to a better house, completely eradicated the disease.

Ophthalmic disease prevails endemically in Malta, and I know that the follicular-looking granulations exist in very many of the inhabitants of the lower orders, among whom the strumous and catarrhal varieties are also remarkably frequent. The predisposing causes, dirt, effluvia, defective ablution and ventilation, are rife among them; while the exciting causes are to be found in the nature of the climate, the condition of the soil, winds, dust, and glare. Whilst in Gozo, I examined the eyes of a great many children of the poorer classes. These children work in the fields with their parents during the day, and sleep in the most wretchedly confined cabins at night. Vesicular lids were very common indeed, although conjunctivitis appeared to prevail less than in the crowded city of Valetta. When the parents accompanied their children, (as they invariably do, following all strangers for the purpose of begging) I instituted inquiries as to the number of children belonging to one father, and the impression left upon my mind was decided, that where there was a large family (5—8—10), this vesicular condition of the lids was remarkably prevalent, and out of all proportion to the amount of the same disease existing in a similar number of children belonging to different parents. The people are very poor, generally have large families, sleep in wretchedly confined cabins, frequently with their domestic animals, and, judging from the appearance of their skins, could not make use of much water for the purposes of cleanliness. They lead the most healthful out-door occupation, and are remarkably healthy in aspect, though ill-nourished.

So certain do I feel that the prevalence of vesicular disease of the lids is in direct ratio to the amount and degree of defective sanitary arrangements, that I conceive that the palpebral conjunctiva offers a delicate test and evidence as to the hygienic conditions of a regiment. This peculiar condition of the conjunctiva is also occasionally seen in ophthalmia neonatorum, where the conjunctivitis may depend in all probability upon the direct application of the vaginal discharges of the mother to the conjunctival membrane of her infant. Even then such application may be quite innocuous, except under the same unhygienic conditions which prevail with those who

evince a peculiar proclivity to the disease. Indeed the "lochial atmosphere" of the room of a woman recently delivered,—its warmth, and absence of light and ventilation,—are in themselves sufficient causes for the generation of the disease.

What is the nature of the morbid agency?

Some of the men affected, have assigned as a cause the irritation caused by the products of urinary fermentation. Such a cause, however, can no longer exist. Before I had observed this disease, I well remember to have witnessed some facts among domestic animals parallel to those noticed by Stromeyer, which lend some support to this idea. Ophthalmia is not unfrequent in dogs, the apparent product of the irritation of ammoniacal fumes arising from the decomposing excreta in ill-tended stables. A large Newfoundland had a purulent ophthalmia, which was cured by removal from the stable, having previously resisted all treatment; what is still more corroborative of the truth of this, as an efficient cause in his case, the disease recurred upon the return of the dog to his quarters in the stable.

Unfortunately, at that period I had no knowledge of the relation of vesicular lids to ophthalmic disease. These facts must have been noticed and recorded by veterinary surgeons. It has been suggested to me that the emanations from the cloth, of which the soldier's uniform is made, may be a cause of the disorder in question. This is quite possible, (for I understand the cloths are prepared in a way as peculiarly offensive to ears polite), as is the stench which steams from them in a hot guard-room to sensitive noses.*

Parasitic.—My own observations afford no proof that these vesicular granulations have a parasitic origin. I have examined the scrapings of lids again and again, with this end in view, and invariably with a negative result. Wharton Jones's suggestion, that the prominent cause of granular lids might be an animal parasite, because the disorder is cured or relieved by the application of ung. sulphur, I have failed to endorse in any particular. First, the ointment gives in my hands results (identical, if not actually inferior,) to those obtained from other remedial agents. Secondly, microscopic observation fails to detect any such parasite; and the prevalence of the ocular disorder, where no scabies nor any parasitic disease prevailed generally or individually

* The expense, trouble, and extreme care entailed upon any one conducting the quantitative analysis of ammonia in the air of a barrack room have prevented my determining this as a cause of the disease. Observations lately published point to something being done in this way.

in ophthalmic cases, or during ophthalmic seasons. Of the diseases depending upon vegetable parasites, *e.g.*, sycosis, tinea tonsurans, herpes circinnatus, pityriasis versicolor, and porrigo, I may remark, that these have not co-existed with the ophthalmic disease in affected individuals, nor specially among the men of the room which the ophthalmic patients have inhabited.

During the spring of the present year, (1861) diseases of the skin and hair follicles, depending upon vegetable parasites, have been very prevalent, but ophthalmia has not only not been more but actually less, as far as the men of the Royal Artillery and Engineers are concerned, than during the same season of other years.

Is the disease an artificial or factitious one, produced by the malingering soldier?

It has not been clearly proved that the specific disorder in question, marked by the peculiar anatomical characters I have enumerated, has ever been, or could be generated by ordinary means of irritation. It may be, but *I can trace no reliable instance of its having been so produced.* That *an* ophthalmia may be so originated I have no doubt, but very considerable doubts as to whether *the* ophthalmia can be so induced. That where the vesicular disease of the lid, however small, is pre-existing, the more advanced stages of the affection can be produced, the local vascularity and irritability marvellously increased, and the disease protracted, by the application of irritants and friction on the part of malingerers, I am positive. Indeed, I may go farther, and state that I have, upon more than one occasion, had pretty positive evidence of such artificial production of a severe form of the disease from one of a slight character. In many cases the diseased state became aggravated, ameliorated, and again recurred, under circumstances so very suspicious, as to leave no doubt in my mind that the men had been tampering with their eyes. This is a far different thing, however, from asserting that all soldiers' ophthalmia arises in such a way. The fact of the disease being endemic to certain countries, its prevalence and intimate connection with European armies generally, the way in which it spreads, the periods of epidemic violence, the different classes of persons and sexes attacked by it, and the regular etiological history which it possesses, are a sufficient answer to those who totally disbelieve in soldiers' ophthalmia as a natural disease.

Occasionally, as I have shown, an officer may become the subject of the disorder. Women and children are frequently attacked. Non-commissioned officers, of steady character, long

service, and occupying lucrative local posts, have been so attacked, while (what is a very strong proof to my mind), a few of the *convicts at the Gibraltar establishment, who had nearly completed their periods of transportation, were attacked with severe forms of the disease,* and their eyesight permanently affected. Some military surgeons have thought that the men might generate or aggravate the diseased action by applying urine to their eyes. It may be so, and indeed I know that it has been in a few cases proved so; but it is quite inadequate to explain more than a very small minority of the cases, on the one hand, and on the other, there can be little doubt that the operation of other causes are both adequate, and actually do, produce the disease.

Contagion.—There can be no doubt that the disease is both contagious and infectious. Many observers are inclined to think that the spread of the disease is mainly, if not entirely, due to such agency.

Bendz, of Copenhagen, relates the origin of the disease in the Danish army, in 1851, previous to which it did not prevail. From his statements, I gather it to have been imported into Copenhagen by some prisoners of war. When peace was concluded, the Danes recruited in Schleswig, and numbers of men who had previously served in the armies of the Duchies were received into the ranks of the Danish army. An ophthalmia, marked by the peculiar appearances described, appeared in the regiments into which the recruits had been received. What is still more curious, these troops were afterwards removed from Schleswig to Copenhagen, and this ophthalmia spread rapidly, disseminating itself among the civil population, apparently through the medium of discharged soldiers. Granulations among the men afterwards recruited were found to be very frequent, *e.g.*, in 1856, 320, out of 2,600 recruits, were found to have the disease in different degrees.

Mr. Nesbitt states that granular conjunctivitis has been the plague of the convict prison at Gibraltar ever since its formation in 1842. At first, when the men were fewer, and lived in well-ventilated hulks, abundantly supplied with water, the cases were rare and unimportant; but as the prison on shore filled, the numbers attacked gradually increased (*vide* Table), until at length the cases became so disproportionate, that the strictest investigation into its causes was entered upon by the medical officers. As a result of this inquiry, it was discovered, that out of the whole number of prisoners a very large proportion were suffering from the disease in its various stages; (*vide* Tables) that the ratio was less in the "Euryalus"

than in the barrack; that there was a close connection between granular and vesicular lids; that those classes were free from the disease in which no granule had been confirmed, and that the great source of infection was from actual contact. In D. 9, one man (Eady) was alone found healthy, and upon inquiry he was found to be a cleanly man, who *never* washed in the ward, but waited until he could have pure water, and plenty of it. All the occupants of that class, which was the most infected of all, state positively that they were quite free from any ophthalmic taint until prisoner (Netts) was introduced and billeted upon them. This man, a careless Spaniard, was the great *foyer d'infection* from which the worst cases arose and spread. The prison itself was admirably adapted, by its imperfect arrangements, to disseminate the evil, and upon this point the shrewd and intelligent surgeon, in his Annual Report for 1859, speaks strongly. "I regret, however," he says, "to say that granular ophthalmia continues endemic amongst the prisoners. I have been unable to trace its first origin in the prison, but am induced to believe that it was introduced by some Spanish convicts, of whom several are received annually. It has most certainly been kept up by the unavoidable admixture of the men, and the faulty hygienic condition of the prison itself. In one or two instances whole wards have been attacked by the introduction of one infected prisoner. As far as I can observe at present, the disease is propagated, rather by actual contact, than by infection of the air. The great increase in the number of cases in the present year is to be attributed entirely to the confusion consequent upon the alterations which have been made in the prisons, for as the men live in wards, sixteen in each, *closely packed, they are compelled to wash all in the same trough, the same water serving each, unchanged, and then used to wash the floor.*" Time has not yet permitted a fair estimate to be formed of the value of the stringent hygienic measures adopted.* Vesicles are by no means quickly absorbed, and as long as infected men remain, so long will acute forms of the disease continue. Mr. Nesbitt conceives the vesicular disease to be the same as ophthalmia neonatorum, and that one will produce the other. He says that in February, 1861, he saw an infant with purulent ophthalmia, which quickly disappeared under the usual treatment. In the following month he attended the mother, (a woman in a very respectable social position) who was suffering from conjunctivitis of the left eye, evidently due to the presence of a number of vesicles in the lower lid, many of which were already passing through the

* Examination made in March, 1859.

earlier stages to granulation. The baby, he remarks, "rolled in a blanket, and stowed away under the bedclothes, breathing a highly concentrated "lochial" atmosphere, is in an excellent position for catching the disease, and slight carelessness, as the use of the same handkerchief, would suffice to transfer the disease to the mother."

Through the kindness of Dr. Forrest, Inspector-General of Hospitals here, I have inspected the reports of the medical officers of the regiments stationed in Malta during the prevalence of an epidemic of ophthalmia in 1856–7. From the report of the 14th Regiment, I learn that, in 1856–7, the number of ophthalmic cases was 226, out of a strength of 828 men. The history of the regiment, with regard to ophthalmia, is remarkably illustrative of the disease being of a contagious nature, and the tenacity with which it adheres to a body of men when once engendered among them. In 1848, the 14th Regiment relieved the 81st at Barbadoes, and occupied the same barracks as the outgoing 81st had done. This 81st Regiment was very unhealthy from ophthalmia, and the 14th Regiment, in that year, had 94 cases, out of a strength of 597. Ophthalmia prevailed in the regiment after its removal to Canada, as in 1842–3 there were 124 cases in 598 strength, the cases being chiefly, however, among those men who had previously suffered the disease in the West Indies. In 1849, the head-quarters of the *regiment in England was split up, with the effect of directly diminishing the amount of the disease. In* 1853–4 *there were only* 19 *cases in* 919 *strength.* The following facts were made out relative to the Malta epidemic of 1856–7. At the height of the epidemic, the regiment moved to a barrack vacated for them by the 28th Regiment, the men of which were not suffering. The disease not only remained unchecked, but actually increased in intensity, showing that there must have been other causes at work than mere defective barrack accommodation. The married soldiers suffered in the least degree—the officers' servants next. One officer only was attacked, and it is doubtful whether this was a case of the military form of ophthalmia. The women and children suffered comparatively little, and these from the catarrhal and strumous forms of conjunctivitis. To show that the exciting causes—sunlight, dust, variations of temperature, guards, &c.—were not the only and essential causes operating, we have the fact that the tailors of the regiment suffered equally with the other men, though exempt from such causes. As to the contagious nature of the disease, there are the following facts. *Direct contagion,* only one case traced—a woman and child, previously quite

healthy, took the disease after a serjeant (the husband) had been discharged from hospital.

Indirect infectious influence? Eight tailors of the 28th Regiment, healthy men, were attached to the tailors' shop of the 14th. Two of such 28th men took the disease, the remaining six were thereupon removed, and did not take the disorder. The medical officer concludes a very elaborate report with an opinion "that however abstruse the notion may appear, he has been compelled by the facts to infer that a remarkable proclivity to take the disease is engendered among the men of a regiment wherein ophthalmia exists."

The 57th Regiment, stationed in Malta during the same period, suffered also from ophthalmia; 198 cases occurred, of which 30 were relapses. The regiment commenced to suffer ophthalmia at Balaclava and Kinburn in 1855–6, and the predisposing cause was therefore present. The married soldiers suffered little or nothing from the disease; the officers' servants almost not at all; the women and children slightly, the cases which made their appearance among the latter having a constitutional or strumous origin. Three married soldiers, previously healthy, became the subjects of ophthalmia after sleeping in a tent in which two men affected with the disease were quartered. The tailors of the regiment also suffered in an equal proportion with the other men.

The 71st Highland Light Infantry had not suffered from any ophthalmia in the regiment for years. The regiment was stationed in Malta at the period of the epidemic referred to. Only 23 cases of ophthalmic disease made their appearance. These 23 cases were apparently all catarrhal ophthalmia, for the average duration of treatment with them was only eight days; the conjunctivitis was common alike to officers, men, and servants, and prevailed at different periods in a sporadic manner. In none did the disease prove chronic, nor result in granular lids. The same exciting causes were in operation of course as in the other regiments.

The 28th Regiment suffered relatively little, no cases occurring among the officers, women, and children.

The Royal Artillery, Engineers, and Malta Fencibles were comparatively exempt.

During 1860, twelve men of the Royal Artillery have suffered from this form of conjunctivitis. Seven of them belonged to No. 3 Battery, and were members of the same mess (No. 6). They occupied 12, 13, and 14 rooms at Upper St. Elmo. A convalescent from hospital, perfectly free from ophthalmia, was exposed to the influence of an ophthalmic

patient of another corps, and he had vesicular granules developed in the left eyelid. Two men belonged to a healthy battery, No. 8, one of whom, from the crowded state of the rooms of No. 8 Battery compared with No. 3, were attached to the latter battery, slept in No. 12 room, using the basins, &c., of the men of No. 6 mess. One case could not be traced. The remaining two men belonged to No. 1 Battery (healthy), caught the disease whilst prisoners in the military prison. No. 1 Battery at the time had a separate fort from the other men of the brigade. The affected men in question gave the following history:—The military prison was in a very crowded state, so that many prisoners had to be confined in the cells at Upper St. Elmo. These prisoners were not marched down to the lavatory of the prison, but washed out of two tubs, the water not being changed for each man, so that from 20 to 40 men washed in this water. A prisoner (Private S——, 15th Regiment,) was one of the first to suffer from ophthalmia, and the affected men of the Royal Artillery stated that they washed in the water used by Private S——. Until their then present attack they had never suffered from "weak" eyes. At the time of writing this report a trumpeter is under treatment for vesicular lids from No. 12 room.

I may here advert to the strongest instance, of the spread of the disease by contagion alone, which has occurred within my observation.

A married officer, holding an important staff appointment, in opulent circumstances, and residing in one of the largest and best houses in Valetta, sent for me to see one of his children suffering from ophthalmia. I was surprised to find that the child had vesicular lids, and still more so when I discovered that nearly the whole family had indubitably vesicular lids, mostly in a latent stage. The English nurse was affected, also the baby. I next discovered that a native wet-nurse had *lids advanced to a chronic and confirmed stage of the disorder*; the baby slept with her. The children were frequently all bathed in the same water. An officer of the same department, who had arrived but a few days at the station, was temporarily put up in the quarters of this affected family. His nurse and child occupied the same *day* nursery, *but slept in a separate room,* and used *separate washing utensils.* They were *perfectly free from the disorder.* These facts leave no doubt in my mind that the native wet-nurse's lids were the "fons et origo mali" in the house.

Many cases were so very well marked that I made a point of bringing them to the notice of some of the military surgeons of the station.

I have seen one eye affected, and during treatment the other eye become so, apparently from the trickling of the water used in washing, or the tears, from the affected to the healthy eye.

As far as the Danish army is concerned, at any rate, there appears to be a greater proclivity in recruits and young soldiers, compared with old ones, to take the disease.

Dr. Bendz gives the following:—Garrison of Copenhagen, 4th battalion of line, 1855, received 340 recruits; of this number, 84 brought the malady, 41 had vesicular granulations without any inflammatory reaction, 35 had vesicles, with redness and vascularity, 1 confirmed or solid granulations, and 6 the catarrhal form of the malady.

Granting, as we must do, that the disease is both infectious and contagious, it must be stated that it is not so at all times and during all stages. The Belgian and Danish observers, with Von Græfe and others, seem to have tolerably satisfactorily proved this. Eble, who has written upon this subject, observes that different degrees of intensity in the inflammation set up by these granulations also produce different and proportionate degrees of severity in the inflammation caused by their contagious agency; hence, mild and severe cases, he thinks, ought to be separated. Although the muco-purulent stage and the stage of active local progress seem to be the periods at which the contagious properties are most developed, I nevertheless believe that there is not any stage at which the disease may not spread in the direct way, as by using the same water for ablution, washing utensils, &c.

Dr. Eiselt, of Prague, has recently propounded the theory that the infectious morbific influence is due to the presence of pus cells, floating in the atmosphere, surrounding ophthalmic patients. He states that by means of M. Pouchet's aeroscope (used for the detection of floating vegetable and infusorial germs), he has discovered pus globules suspended in the air of ophthalmic wards. An important discovery, if true, but inadequate to explain all the phases of the contagious properties of ophthalmia.

Treatment.—I would premise what I have to say upon this head by remarking, that it is only intended to indicate what my own observations would lead me to suggest, with a desire (as far as practicable) to avoid any unwarranted dogmatical and positive assertions.

Prophylactic measures.—These I regard as by far the most important, as indeed I have very little faith in any mere therapeutical influence we possess over the disorder. The

measures to be pursued can be easily gleaned from the resumé at the end of this paper. Sometimes we can cause a sudden check to the progress of a threatened epidemic by finding out and removing the exciting cause, as has been well illustrated lately. The 2nd battalion 23rd Regiment removed to a barracks in Malta called "Polverista Gate." The name sufficiently indicates the prevalence of dust. Ophthalmia commenced among the men, and made rapid progress, but was quite checked by the common sense suggestion of Dr. Tydd, the regimental surgeon, viz., to water the roads and neighbourhood of the barracks.*

Time as an element in treatment.—It is astonishing what changes ensue in time, even in cases of the severest forms of the disorder. There is naturally a strong tendency to recovery. If strong caustics have been avoided, and there has been no tampering on the part of the individual, the disease, I am positive, ought very rarely indeed to eventuate in loss of vision. Protracted as recovery may be, it comes at last;—or at least so beneficial a change that the disease again appears latent, and is tolerated by the patient. The granulations smooth down, and become even. As the evidence of attrition diminishes, the corneal deposits altogether clear away, or leave behind trifling specks, where ulcers have cicatrized.

1*st Vesicular Stage* hardly admits of or requires treatment, further than perfect cleanliness, good air, removal from the exciting causes of conjunctivitis, the occasional use of a mild astringent wash. If eradication of the vesicles is aimed at, the removal of the individual entirely from a gregarious mode of life, and change of air, may procure that end.

2*nd Stage.*—A few leeches, or a larger number, proportionate to the amount of vascular engorgement; cupping; a purgative, with the use of a weak solution of alum; nitrate of silver (gr. ii.—iv., ℥i. aquæ) or bichloride of mercury, with extract of belladonna, as collyria; the frequent application of the eye-douche, or a refrigerating lotion constantly applied to the eyes, if the nervous irritability be great. These,—with confinement in a well ventilated ward, upstairs, and remote from hospital or sewage effluvia,—serve to remove the vascularity in a few days, though rarely the vesicles themselves.

My own opinion of local depletion is very high, if actively employed in acute cases, and not too long continued. The state of the eyes sympathizes with the general condition of the patient's stomach, &c., and there is a tendency in all stages for

* That Vesicular and latent disease of the lids was present in the men of the regiment long prior to this I know from personal inspections of them.

the patients to have dyspeptic symptoms, coated tongues, and pot-bellies, therefore the diet should be regulated, light, and without any stimulants. Treatment is highly successful in this stage.

3rd *Stage.—Vesicular exudation.*—The same remedies, and more vigorously applied, are indicated, particularly at the outset, but restrained by a knowledge that mere depletory remedies are both injurious and useless in the chronic stages of the disorder. Blisters prove useful; a very frequent use of the eye-douche; mild astringent collyria, mineral and vegetable, frequently varied; the use of glycerine at night to prevent gumming of the lids; exercise in the open air just before sunset, and sea-bathing. Quinine, porter, &c., only when the state of the patient requires their administration. An upstair ward is the best. Change of air, or the approach of wintry weather will often alone cure many cases.

4. *Purulent ophthalmic stage* (acute).—The plan in which I have the greatest confidence includes the following measures. The application at once of relays of leeches in large numbers, 30 to 60; cupping the temple; the administration of a purgative; belladonna ointment applied to the brow; collyria of alum (gr. v.—℥i.), nitrate of silver (gr. iii.—℥i.), frequently dropped into the eye, and the constant application of fomentation, or better, cold irrigation steadily maintained; the division of the chemosed membrane, such treatment to be employed during the first week, say. Afterwards the application of weak collyria (frequently varied), change of ward; blisters kept open; the use of quinine and stimulants, if indicated; segregation from other and bad cases; or perfect change of air. That the application of strong caustics, or strong solutions of nitrate of silver, &c., to cut short the disease, only tends to protract it, I am quite sure; and my impression is that the keratitis and corneal deposits are greater in those cases in which strong applicants have been used, than in others more temperately treated.

5. *Granular lid stage.*—The plan of treatment is somewhat similar to that of the last, but modified by the knowledge that we are treating a disorder essentially chronic, and one which spontaneously tends to recovery in process of time. Segregation from other cases, the removal from hospital air, abundance of cold water, and a strong faith in time as an element for good, are the most important items in my mind. As to the various collyria, caustics, and special modes of treatment, so strongly recommended and vaunted at different times, all I can say is, that I have never observed any facts warranting the slightest

reliance in any one of them. Fixing the lids over the eye, and so retaining them, only answers in cases wherein a suspicion of foul play exists. As to burning down and repressing redundant granulations, by sulphate of copper, lunar caustic, &c., I firmly believe, (what the careful analysis supplied me by Mr. Nesbitt teaches) viz., that we prolong the disease and complicate it by new morbid phenomena of our own production. It ought not to be forgotten that the disease is remedied by natural processes; that to remove the old granulations you must cauterize even to the tarsal cartilage, and that the affection improves not by a merely rapid liquefaction of the cell structures of the granulations, but by a change of such cells into a fibroid tissue, concurrently with the absorption of liquid and degenerating products, and the exudation of the surface cells as muco pus. During the whole treatment we must be upon the watch that the deeper tissues do not become implicated, that a syphilitic iritis is not also making progress, or that a sclerotitis or irido-choroiditis are not set up, for then in addition to mercury, copious local depletion, and division of the cornea, with evacuation of the aqueous humour, may be required.

The state of the conjunctiva affords, too, an index to delicate barometrical changes, if we are only careful to observe them, objective and subjective symptoms becoming markedly worse during the prevalence of easterly and southerly winds, with the moist, hot sirocco; on the other hand, such symptoms rapidly improve during the prevalence of polar dry winds, or westerly ones, and during ozoniferous winds, provided they be dry ones.

The application of liquor potassæ, as directed by Mr. Dixon, I have tried in two cases. That the alkali permeates the parts, and chemically dissolves the nearest tissues, is true enough, but its application is attended with great pain. Mr. Dixon speaks of six weeks being consumed in the treatment; my scepticism suggests that the six weeks and air were the curative agents rather than the liquor potassæ.

Resumé of the preceding paper in the form of propositions.

1. That the palpebral conjunctiva contains a well-developed and very vascular connective tissue layer, with the papillary structures, Meibomian glands, and an epithelial covering, consisting of numerous cells, pavement and polygonal upon the surface, spheroidal, smaller, and in successive layers beneath, besides certain compound racemose glands (Krause's), situated in the corium layer, close to the retro-tarsal fold.

2. That various forms of ophthalmia occur in military as in civil life, particularly the catarrhal and strumous forms.

3. That military vesicular ophthalmia is a specific affection, having always the same essential characteristic features, prevailing endemically or epidemically.

4. That it commences as an affection of the connective tissue, stroma, or the cells (epithelial) placed in contact with that tissue in by far the larger number of cases; while in others, it is connected with the stroma immediately surrounding Krause's glands, in the form of vesicles. That such vesicles are not ordinarily the product of inflammatory phenomena.

5. That, although the so-called vesicular or sago-grain granulations may appear during the progress of other disorders, there is no positive evidence to prove that the catarrhal and strumous forms ordinarily generate the vesicular lid, but rather that the latter is a specific disease, which may precede, accompany, and modify any diseased state of the conjunctiva, with which it is conjoined; or that it arises concurrently with ordinary conjunctivitis, when the subjects of it are living in unhygienic conditions.

6. That the so-called vesicular lid may exist without any inconvenience or symptoms arising, and the disease may so continue in one stage and latent, for an indefinite period.

7. That, upon the occurrence of exciting causes, an inflammatory reaction occurs, limited primarily or throughout to the palpebral conjunctiva, conducting, according to its extent and duration, through all the phases and stages of the disease, from the slightest blenorrhagia, up to the most acute purulent ophthalmia.

8. That the period of maximum prevalence of the disorder is the first and commencing second quarters of the year. That solar heat, moist winds, white glaring surfaces which reflect light and heat; dust and frictions, and the heavy dews prevailing at this season, seem to be powerfully exciting causes. That the epidemic prevalence of vesicular ophthalmia during the spring and summer seems to be connected with the increased temperature, and the light rains, causing rapid decomposition, and evaporation of miasma.

9. That, although the disease rarely appears to occur spontaneously, it is more than probable that overcrowding, bad ventilation, and defective ablution, are themselves adequate to originate it. That the true vesicular ophthalmia has an intimate etiological relation with other miasmatic disorders, and that the state of the conjunctiva offers a delicate test of the hygienic state of a regiment. The prevention and removal of

this form of ophthalmia is therefore more within our control than is generally imagined.

10. That the most powerful cause of the spread of ophthalmia in a regiment is undoubtedly some morbid influence engendered by the presence of individuals suffering from the complaint. That the disorder spreads most frequently in the direct way; and the virus, whatever it may be, is of miasmatic origin, and falls within the laws of infection; such infection, proceeding from an affected individual in badly ventilated sleeping rooms during the night, and more directly through water used for ablution and washing utensils. That although the disease may possess infectious properties only during certain stages, and under certain conditions, it is probable that the disorder may be communicated directly, *during any stage*, to non-affected individuals, washing in the water which has been before used by persons the subject of this form of ophthalmia.

11. This explains how it is that a tendency to ophthalmia adheres tenaciously to the men of a regiment, and why, when an epidemic occurs, or a concurrence of exciting causes prevail, the regiment which has before suffered from ophthalmia will be sure to do so again.

12. From the fact of soldiers being gregarious, and peculiarly exposed to miasmatic influences, (while the vesicular stage manifests itself by no subjective symptoms,) we can explain how ophthalmia is a soldier's disease, and how difficult such disease, when once engendered, is of eradication.

13. This knowledge of the etiology of the disease sufficiently indicates the necessity of breaking up an affected regiment into small companies;—the prohibition of such regiments from being stationed where ophthalmia is endemic, or the exciting causes to ophthalmia of any kind exist.

14. That it points also to the necessity for the largest amount of cubic space in the barrack rooms of such regiments, for full and free ventilation; and the supply of separate washing utensils for the men, with an unlimited supply of water, and the institution of bathing parades.

15. That the strictest supervision should be exercised in the prevention of men, already affected with vesicular or granular lids, joining companies or troops exempt from that disorder.

16. That, in the treatment of the disease perfect cleanliness, upstair wards thoroughly ventilated, and giving ample cubic space, with a separation of the milder from the more acute and advanced forms of the disorder, and exercise in the open air daily, seem to be the most important indications.

17. That any treatment,—by strong caustics, collyria, &c.,—with the view of cutting short at once the disorder, not only is inadequate to reach the tissue in which the morbid process runs its course, but is productive of mischief in tending to complicate the phenomena with those of our own production, and directly leads to opacities of the cornea, and chronic alterations in the tissues of the lids, *e.g.*, entropium; ectropium; deviations of the lachrymal puncta; zerophthalmos, &c.

18. That change of air is the best of all remedies in the advanced stages and in protracted cases.

19. That the disorder is occasionally kept up by malingering soldiers, and, when a suspicion of such exists, it is well to close the affected eye entirely, by strapping, and make the treatment uncomfortable in its nature.

20. That time forms an essential element in any treatment,—a tendency to recovery from the disorder in process of time being well marked.

Results of the Examination of the Eyes on board the Euryalus, March 13th, 1859.

Total Number.	Granular Lids.	Vesicles in Lids.	Tendency to Vesicles.	Distribution.
121	2	28	5*	Main deck only occupied. Nos. 5 and 6 being allotted to the boarders. Nos. 7, 9 and 10 to working prisoners, averaging about 40 men in each class.

The arrangement of halls and numbered wards is new. The lower floor of the prison on shore is divided into two halls containing 21 wards, each ward constructed to hold 16 men. A and B upon floor. C and D halls upstairs. So that a ward in either hall has the letter and number to distinguish it, *e.g.*, A 1, D 9.

Analysis of Cases in A Hall.

No. of Ward.	Vesicles in Lids.	Granular Lids.	Remarks.
1	7	None	
2	11	1	
3	8	None	
4	5	..	
5	2	..	
6	5	..	
7	1	..	1 case of engorged lids.
8	4	..	
9	..	..	
10	3	..	1 tendency to granulation at canthi.
11			
12			
13			
14			

* Appearance of vesicles in these cases doubtful, rather vesicular than not, but not convincing to an unpractised eye.

Analysis of Cases in B *Hall.*

No. of Ward.	Vesicles in Lids.	Granular Lids.	Remarks.
1	9	None	1 weak eyes and congested lids.
2	5	1 slight	
3	7	1 "	
4	4	2 "	
5	12	1	
6	11	2	
7	11	2	
8	5	1	and one engorged lids not carefully noted.
9	..	..	
10	8	1	Engorged lids.
11	8	2	
12			
13			
14			

Analysis of Cases in C *Hall.*

No. of Ward.	Vesicles in Lids.	Granular Lids.	Remarks.
1	3	..	
2	2	..	
3	1	..	
4	7	..	
5	8	1	Slight.
6	7	..	
7	5	3	Chronic cases, 1 just from hospital.
8	6	..	
9	9	1	From Euryalus.
10	4	..	
11	5	..	
12	8	1	Rather granular.
13	5	..	
14	9	..	Not well marked.

Analysis of Cases in D *Hall.*

No. of Ward.	Vesicles in Lids.	Granular Lids.	Remarks.
1	7	1	
2	12	1	Slight, never treated.
3	4	1	One now in hospital.
4	10	..	One lids engorged from childhood.
5	8	..	One has had ophthalmia.
6	8	1	
7	3	1	
8	9	1	
9	5	8	One of men whose eyes were sound, did not use the same water as rest.
10	3	..	One engorged lids.
11	8	..	One has had ophthalmia.
12	4	..	
13	..	..	
14	5	1	
15	6	..	One engorged lids.
16	9	1	

Results of the Examination of the Eyes of the Prisoners in the Prison, and on board the Euryalus, March, 1859.

Location.	Strength.	Granular Lids.	Vesicles in Lids.	Tendency to Vesicles.	Sound eyes.	Ratio.
Prison ..	620	44	298	65	333	
Euryalus ..	121	2	28	5	89	

When the Euryalus was examined, the upper deck only was occupied, the lower deck having been evacuated for some months; of the wards on the upper deck, five only were used.

Nos. 5 and 6, no cases noted. Warders.

7 contained about 38 men.
Vesicular 5, Granular 0.

9 contained about 40 men.
Vesicular 16, Granular 0.

10 contained about 40 men.
Vesicular 7, Granular 1.

Analysis of Cases treated in Hospital.

	1846.	1847.	1848.	1849.	1850.	1851.	1852.	1853.	1854.	1855.	1856.	1857.	1858.
January	..	..	2	..	2	2	13	3	8	3	9	1	3
February	..	..	2	..	4	2	16	4	2	3	10	8	3
March	3	2	2	2	4	1	11	2	3	10	7	4	4
April	2	2	4	5	2	..	5	20	4	5	2	8	1
May	1	1	4	..	1	..	4	12	..	5	2	5	4
June	1	..	..	..	1	2	1	5	..	4	4	5	6
July	1	4	2	..	2	1	..	4	2	4	12	7	4
August	1 relapse	1	..	4	..	1	..	3	8	5	1	4	4
September	..	1	3	..	..	..	1	1	4	4	4	2	3
October	..	2	1	..	1	4	1	2	4	4	4	..	5
November	..	2	2	1	..	8	2	3	2	3	3	1	4
December	..	..	1	..	..	12	1	1	2	11	3	4	3
Prison	8	9	14	9	11	26	39	52	31	53	57	44	35
Euryalus	..	4	8	1	4	7	15	8	8	7	4	5	9
Owen Glendower	..	2	1	2	2	..	..	..	..	1	..	..	..
Total	8	15	23	12	17	33	54	60	39	61	61	49	44
1st Quarter	3	2	6	2	10	5	40	29	13	16	26	13	10
2nd Quarter	4	3	8	5	4	2	10	24	4	14	8	18	11
3rd Quarter	1	6	5	4	2	2	1	7	14	13	17	13	11
4th Quarter	..	4	4	1	1	24	3	..	8	18	10	5	12
Total	8	15	23	12	17	33	54	60	39	61	61	49	44

Seat, Character, and Duration of the Disease.

Year.	Cases reported.	Relapses.				Idiopathic.		Eye affected.			Maximum in Hospital.	Minimum in Hospital.	Average duration in Hospital.	Results and Remarks.
						Without Corneitis.	With Corneitis.	Right.	Left.	Both.	days	days	days	
1846	8	..	2	1	..	5	..	not noted			53	3	17 ·4	1 eye lost.
1847	15	..	..	..	..	13	2	3	4	8	54	2	20 ·17	"
1848	23	..	4	1	1	14	9	6	7	10	206	2	21 ·	1 eye lost, 1 impaired.
1849	12	2	2	..	..	..	5	5	4	3	32	3	12 ·75	Nil.
1850	17	3	3	..	..	..	4	6	6	5	122	2	27 ·56	Nil.
1851	33	3	1 eye lost 3 and 2 doubtful	..	..	..	5	9	8	2 not noted 14	118	3	17 ·84	Granulations not noted in 5 cases.
1852	54	6	1 lost	..	..	..	6	7	11	3 not noted 32	73	3	13 ·32	5 granular.
1853	60	6	3, 1 lost	..	..	..	9	10	9	1 not noted 40	81	1	18 ·26	9 ditto.*
1854	39	7	1	..	..	..	8	7	15	3 not noted 14	..	..	..	20 ditto, 1 lost.†
1855	61	15	..	..	..	..	12	9	6	6 not noted 39	262	2	32 ·80	34 ditto.‡
1856	61	9	3	..	..	..	13	11	6	4 not noted 39	129	1	22 ·90	39 ditto, 1 lost.§
1857	49	5	1	..	1	..	18	11	7	6 not noted 25	247	2	33 ·16	23 ditto.
1858	44	5	3	..	..	..	11	14	6	8 not noted 14	127	1	20 ·05	25 ditto.

* Infection first noted, one man getting the disease from lending an ophthalmic patient his towel.
† Netts, a Spaniard, a fruitful source of the disease. ‡ Hudson, a lunatic, greatly increased the area of disease in hospital.
§ O'Lochlan's eye lost.

HEMIPLEGIA WITH CONVULSIONS.

By Africanus Horton, M.D., Edin., Staff Assistant Surgeon of Her Majesty's Forces on the Gold Coast.

It will undoubtedly be useful to state that the uneducated natives of the Gold Coast of Western Africa are very sceptical as to the superiority of European skill in medicine when compared with the random treatment of the Fetishman, and thus a case is seldom brought before him until it has arrived at its last extremity. I questioned one day one of the promoters of this silly idea their reasons for thus opposing a Fetish doctor against scientific men. "The fact is," said he, "you European doctors do not know the system of the African; for it is composed of a great number of holes running in every direction, and giving free circulation of the blood, whilst the white man has but very few holes. When an African goes to England," said he, "these holes are closed, and so he becomes diseased and dies; and when the European comes to Africa, not being provided with the necessary holes in his body, the climate becomes prejudicial to him."

The case I am about to relate is one of very great interest, and which, amongst many others, I was called to attend in the very last stage of the disease.

M.A., æt. 36, was seen by me suffering from hemiplegia with convulsions on the 10th April.

History.—Patient was in such a low condition that she could not speak. Her friends gave the following account:—About three months ago she was delivered of a healthy child, previous to which she had had three children, the eldest girl about sixteen years old. After her delivery she was never well, having complained of pain in her abdomen, which continued for some time. She improved a little, but when she began to walk about the pain returned; she was never exposed to the cold damp air of the evening. About two months ago she felt uneasiness of the left side, and was unable to move her leg or arm; this was succeeded by a slight twitching sensation, which increased rapidly until the whole of the left extremities became affected with a continued spasmodic contraction and inability to use the limbs; the face and neck afterwards became involved in the contraction, and then at intervals a convulsion of the whole body took place. She had been taking all the time native medicine without any effect.

The following were the symptoms I observed on my first

visit:—There was a general appearance of great weakness and depression of spirits; no emaciation; the left leg and arm act sparingly to the will, and were continually under a severe convulsive spasmodic contraction; the muscles of the right side of the face underwent continual twitchings; at each quarter of a minute each arm and leg is attacked with a severe spasmodic contraction; at each quarter of an hour patient complains of a creeping sensation over the region of the stomach and then a spasm of the diaphragm, leading to excessive difficulty of breathing; staring eyes, and the patient throwing herself about; the right leg and arm became irregularly contracted; afterwards the contraction became general; arms, legs, and muscles of the face and the whole body convulsed; the teeth perfectly and forcibly clenched; muscles contracted; eyes fixed and staring; breathing suspended; this state lasted only for two or three minutes, and the fit gradually subsided, but the spasmodic contraction of the lower and upper extremity still continued as before; the sight rather dull; sensibility below the ordinary standard. DIGESTIVE SYSTEM.—Tongue coated with a white fur, especially towards the centre and back; the appetite bad; bowels irregular. GENITO-URINARY SYSTEM.—Urine scanty and high coloured, depositing a sediment; no pain or uneasiness felt in the region of the uterus. PULMONARY SYSTEM.—Normal. CIRCULATORY SYSTEM.—The heart's action is weak, occasionally violent palpitation; radial pulse 90, weak. INTEGUMENTARY SYSTEM.—Normal.

I ordered that she should have the free use of the cold water bath, an aperient draught in the morning, and a dose of ergot of rye three times in the day.

12th.—Patient felt a little easy, but not better; the bowels sparingly opened by the medicine, but became confined again; appetite better.

Ordered, a pill composed of compound colocynth and blue pill to be taken every night, and a dose of castor-oil in the morning; a mixture, composed of assafœtida, aromatic spirits of ammonia, and Battley's sedative, to be taken every four hours.

14th.—The medicament produced a decided effect; the continued spasmodic contraction of the extremities almost abated; the fits came on every hour instead of every quarter of an hour; appetite improved; bowels opened.

Ordered, pills and mixture to be continued; the diet to be generous, with port wine, *which was obtainable*.

26th.—Patient decidedly improved, and expressed herself so; the spasm of the extremities entirely disappeared; pulse 85, strong; the fit came on now only four times a day.

28th.—Patient still improving; she suffered from slight ptyalism.

Ordered pills to be discontinued.

May 3rd.—Patient had a severe attack of dysentery, but all the other symptoms were as favourable as before. An astringent mixture was ordered.

6th.—The dysentery had stopped. I met my patient sitting up in the drawing-room; the fits now come on irregularly twice or thrice a-day, and she feels herself much better, but complains of a severe excruciating pain in the head; bowels costive.

Ordered, small doses of sulphate of zinc and laudanum, with a diaphoretic powder, to be taken three times a-day; 1 gr. of opium at bed-time; bowels to be opened with castor-oil.

9th.—Pain in the head becomes intolerable, all the other symptoms abate; she completely recovers from the ptyalism.

Ordered, head to be bathed with a cold evaporating lotion.

15th. Stomach becomes irritable, and could not retain the medicine. Ordered, a pill of sulphate of iron and quinine, and the lotion to be continued.

17th. Stomach again becomes irritable; bowels irregular; head-ache, very severe; appetite bad; fit occurs about four times a-day, but not very severe.

Ordered, a mixture of assafœtida and laudanum to be given in drops, and 1½ gr. of opium at bed time.

18th.—Patient had sleep at night; headache the same.

21st.—Patient has her appetite improved; bowels regular; feels weaker; fits come on five times a-day; the head-ache the same. Ordered, a mixture of quinine and sesquichloride of iron; to be taken three times a-day.

A day after this I received orders to remove from the detachment at Anawahoe to that at Dix Cave, a distance of about 110 miles. The last I heard of her was that the disease proved fatal.

Commentary:—This case is an addition to a great many cases where a distal irritation leads to the affection of the nervous centre. The irritation was at first in the uterus; the nervous attack was hysterical; not being checked it produced a serious irritation in the right side of the nervous centre. It would appear that the uterine circulation ceased, but that the effect on the brain had been very serious, and so the mischief continued. When the assafœtida mixture and the colocynth and blue pill were given the immediate beneficial result was remarkable, but there was an intolerable head-ache, which probably depended upon some serious injury having been produced in the brain.

CASE OF PUERPERAL CONVULSIONS AFTER DELIVERY.

By William Mair, L.R.C.P., L.R.C.S., Edin.

Case.—H. T., aged 21, married, first pregnancy, full time. Labour began at 3 p.m. on September 15, 1861; liquor amnii escaped 10.10 p.m.; child born at 10.20 p.m.; placenta expelled from the uterus at the same time; removed out of the vagina at 10.25 p.m.; no complications; had presented in the first position. Female child, living. Duration of labour, seven hours twenty minutes. She sobbed a little during the second stage of labour; gave her ʒss. of ergot to hasten the expulsion of the child.

September 16th.—I was sent for about 4 a.m. Found her in a fit. She had been convulsed for an hour. She was conscious, and talked a little before the first fit; afterwards she appeared to be quite unconscious, even in the intervals. No flooding. Abdomen distended with flatus. ℞. Calom. gr. x., Pulv. jalap. ℈j. statim. I took forty ounces of blood from her arm, put a blister on the nape of her neck; her hair was cut, and cold lotion applied; the abdomen and feet constantly fomented; sinapisms to the legs. In the morning administered a clyster of gruel and salt, a second in the forenoon, and a third in the afternoon. After each clyster there was a great discharge of fæces, which must have been lodged in the colon during labour, as there was none in the rectum during the passage of the child through the pelvis. Small doses of calomel were given, with a view to produce salivation, and antimony to nauseate. Such was the treatment pursued during the day. The convulsions became more frequent and intense each time. three and four in the hour. The pulse ranged about 98, never more, full and regular. Foamed very much; tongue brown, swollen, protruded. No motion, except those caused by the clysters. Passed water several times. Uterus contracted; lochia present.

9.30 p.m.—I put her under the influence of chloroform. Five times before midnight she opened her eyes and rolled them about; twice after 12 she opened her eyes and stared. While under the influence of the anaesthetic, the heart acted normally; pulse came down to 78. The movements of the

chest regular, equal, and of normal amount; respiration 28, easy and equal. No convulsions; perfect relaxation of all the muscles. She lay on her back. Placid expression of countenance. The distention of the abdomen went down directly she was under the influence of the chloroform. Administered ℈j of calomel.

September 17th, 2.30 A.M.—She stretched herself, turned over on her right side, and fell asleep. Stopped the inhalation. She slept naturally and looked like a person fatigued with much exercise, but otherwise she appeared to be in a gentle natural sleep.

5.30 A.M.—She awoke, sat up in bed, did not speak, looked about her, and fell back convulsed. She was again put under the influence of chloroform, but it did not arrest the convulsions; it lessened them in intensity and frequency, two and three in the hour. Pulse 88. Pupil sensible to light. Gave ℈j of calomel.

Noon.—Convulsed twice in the hour; beginning to be restless, and tossing about. Continued the inhalation.

4 P.M.—Still convulsed, but not so frequently. Impulse of heart great; pulse weaker. Respiration laboured, loud; a gurgling in the throat. Bowels moved for the first time; the motion a large one; purged several times afterwards. Continued the warm fomentations to the body and legs; sinapisms to chest and throat.

8 P.M.—Convulsions ceased, and did not return; restless; rolling the head from side to side; pupil small. Pulse 80; impulse of heart not so great. Respiration loud; no gurgling in the throat.

September 18th, 9 A.M.—Respiration stertorous; pulse very weak, slow, hardly distinguishable in the afternoon. Lochia present. Unconscious; moaning; pupil contracted, and insensible to light. Continued so without return of consciousness till 7.55 P.M., when she died.

She was a strong, stout woman; weighed twelve stone six months before her confinement; never known to have had a fit previous to her confinement; never took castor-oil, always pills, which sometimes moved her bowels, oftener not; was always costive; had a hearty appetite. Did not complain of pain in the head, giddiness, or any other premonitory symptom previous to her confinement, or previous to the first fit, though the nurse noticed a sort of drowsy look about her shortly before she was convulsed. She died 69 hours 35 minutes after her confinement; was *awake and sensible* 4 hours 40 minutes; was *awfully* convulsed $18\frac{1}{2}$ hours; was *quiet* under the influence of

chloroform 5 hours; was *asleep* 3 hours; was again under the influence of chloroform 14½ hours, which *did not arrest* the convulsions as it did before, but *lessened* them in intensity and frequency; was 23 hours and 55 minutes in a *comatose* state. No post mortem.

Remarks.—It is necessary in epileptic convulsions, which are sensori-motor movements, to have impressions made on afferent nerves, which impressions are conveyed to the sensory organ from thence to the seat of the motor power in which nerve force is generated and transmitted downwards. In this case doubtless the impressions were made by the fæces in the intestines; these impressions were conducted to the seat of sensation. The seat of sensation may not in itself be the seat of consciousness, for consciousness is an attention of the mind to the impressions conveyed to the sensory seat, so there may be sensations without consciousness; or, in other words, the sensory seat may have impressions transmitted to it without the mind attending to their perception, either because the mind is abstracted, or on account of the change that has taken place in the sensory seat,—such is unconsciousness. The perception of impressions does not depend on the amount of the impressions, but on how they have been received by the sensory organ; the more gentle an impression, the more vividly do we perceive it, whereas an impression of great amount produces, according to its degree, stupor or unconsciousness. In this case doubtless the impressions were of great amount, and the loss of consciousness, at first an abstraction of the mind on account of the violence of the impressions, afterwards a change in the nervous force, till at last the nervous force was entirely lost, and there resulted a total loss of consciousness, as at the close of the case. The motor seat may be acted on either diastaltically, *i.e.*, through an influence from the sensory organ, or directly by the will. The diastaltic action, when the mind does not perceive the impression, is a state of rigidity of the muscles, then convulsions, according to the force sent from the sensory organ.

With regard to the treatment pursued in this case, there is little need for remark. The bleeding did no good. The chloroform at first completely deadened the sensibility; why afterwards it should have, in a great degree, lost this power, I know not; perhaps the impressions were greater on the sensory organ more tender to the impressions.

Part II.

ORIGINAL RESEARCHES IN PHYSIOLOGY AND MORBID ANATOMY.

ON THE ANATOMY OF MUSCULAR FIBRE.

By Samuel Martyn, M.D., M.R.C.P., Physician to the Bristol General Hospital, Lecturer on Physiology and General Anatomy at the Bristol School of Medicine.

Plate XIV.

Amongst the foremost duties which recur annually to every teacher of histology is that of demonstrating and explaining the tissue placed at the head of this paper; and although nothing can be easier than to do this for certain simpler varieties of "nonstriated" muscles, the higher forms of this tissue present—such at least has been my own experience—most annoying difficulties. A careful study of what had been already done only revealed to me that there were as many opinions as histologists, and so impossible did it seem to eliminate differences of description or representation, that I at length gave the task up in despair. During the past four years I have accordingly, from an independent point of view, examined the muscular tissue of many animals, in order to see and show what I taught; and, though far from believing that the structure can be as yet physiologically and chemically understood, I think that by thoughtful manipulation and the patience needful for getting rid of optical errors in working with very high powers, the morphological difficulties have been virtually solved, and that I can even show how so great a variety of opinions have arisen.

The difficulty, and consequent difference of opinion, is as to the ultimate structure of the highest development of the highest form of muscular fibre in mammalia; this must be made out by actual, unbiassed observation, although a more or less deductive method, in which the structure is very much inferred from the easier dissections of lower animals, has not been altogether without use. Thus Signor Amici has recently made a series of beautiful observations on the muscles of a species of fly, but has afforded a warning to future observers not to rely

on analogies, for his theory of the highest fibrillæ, deduced from the former, is, without doubt, erroneous. Professor Kölliker relies upon fibrillæ of the bug, meat fly, and river crab [Figs. 95, 96, and 114, of the Handbook, 3rd ed.]; and though Messrs. Busk and Huxley had insisted that the supposed fibrillæ were really *fibres*, he again declares in his last essay, that "Harting, Aubert, und, soviel mir bekannt, alle anderen Autoren" are of his original opinion. On the other hand, the fibre of fishes was recommended for this study by Mr. Bowman, "because they usually cleave into fibrillæ having very clear outlines," and he especially mentions the salmon, the muscles of which are highly developed, and therefore yield satisfactory results.

It is well known that the generally received idea of muscular structure in this country at least, has been derived from a study of the higher mammalia, and that a great advance was made by certain observations of Drs. Carpenter and Sharpey. A series of preparations by Mr. Lealand of muscular fibrillæ from the pig showed a structure of a more complex character than had been previously noticed, and which was subsequently found to be present in many if not most well developed fibres. In spite of the confirmation again and again of those appearances, and of re-examinations in insects, crustaceans, and fishes, no histologist, I suppose, rests finally on the figures usually reproduced in standard treatises. Thus, the author of the article "Muscle" in the Micrographic Dictionary, writes of "appearances exhibited by fibrillæ, which cannot at present be satisfactorily explained; sometimes each more highly refractive portion is divided by a dark line:" "at others, the same part appears bounded at each end by a transverse dark line, or both parts are traversed mesially by a transverse dark line." Some histologists omit to notice what has been described by others, to illustrate which I may adduce that it does not appear from about fourteen very closely printed pages on the fibrilla in Professor Kölliker's work (not all embodied in the English version) whether he had himself seen the well-known appearances figured by Dr. Carpenter (Figs. 2, 3). Thus we meet with difficulties in every direction, to overcome which in some degree has been my object, partly by a very careful appeal to nature, and partly by comparing the result with all views which seemed to be the fruits of honest and intelligent work.

I must, however, guard the reader from the notion that there is an exact limit to any one kind of minute form in the muscular system. There is no line of demarcation between "non-striated" and "striated" muscle, and the less we use for this

classification such terms as "voluntary" and "involuntary," and the like, the better. In structure, from the fusiform cells which traverse the foot of Hydra up to a fibre of the biceps, there is a steady transition, a series in which is included whatever exhibits irritability,—"quæ ab externo aliquo contactu brevior fit." Transverse striation may be found in very simple fusiform cells, as in the arterial system of reptiles, non-striated cells may be elongated into fibres having several nuclei (human pylorus), striated fibres often subdivide (extremities), or form networks (heart and tongue), or may be very indistinctly striated (oesophagus), while the sarcolemma may or may not be present. The only law of development which seems to come out distinctly is that rapidity of contraction is always in a direct ratio with clearness of transverse striation.

It will be as well to approach the very focus of dispute, the highest form of mammalian fibre, and to re-examine, aided by one of the ordinary re-agents, muscular fibre from a source which has been much relied on, viz., the loin muscles of the pig. First let a fasciculus from the delicate white fibre, after a maceration of twenty-four hours in proof spirit, be placed under the half-inch simple lens, seen by transmitted light, [I use Quekett's microscope as made by Highley,] and then carefully torn with needles. The fibres will be observed to terminate in points, few being cut across at both ends of a frustule, say half an inch long. The fibres are fusiform, their ends varying a good deal, but most of them being extremely fine. This I mention incidentally, because, though discovered by Rollett in 1856,* it seems to have often escaped notice. Much variety is also observable amongst the fibres, some of which are more translucent than others. The broad, highly refracting fibres are in a more or less advanced state of fatty degeneration, and to such an extent is this the case in delicate white meat that I have ultimately had recourse to the red and coarse fibre of more used muscles. If such a muscle be employed, more opake fibres are seen, and if, with very little fluid on the stage, the needle points be inserted into one fibre after another, some will be found to split much more readily than the rest. The further dissection of these, when isolated, is by no means so difficult as is generally supposed. It requires a steady hand, a well supported arm, and sharp needle points. The quantity of fluid must be so small that the fibre lies still while being dissected, or all is useless. It is not enough to make buttonhole openings in fibres, but every part must be split again, and

* "Ueber freie Enden quergestreifter Muskelfäden." Sitzungsber d. Wiener Akad.

detached ends turned back, so as to open all the angles. Allow then a wave of fresh fluid to spread over the whole, and bring the cover into position. In this way I rarely fail to discover fibrillæ, which present all the material for further study. Under a power of 400 diameters each fibrilla is seen to consist of a row of rectangular "sarcous elements" between which there are clear spaces (Fig. 15). If the power used be increased to 1,200 diameters, and the correction of the object glass, which will be different for every fibrilla on the field, according to its depth in the fluid, carefully adjusted on Mr. Wenham's plan, a series of totally new and important points come to light.*

The first thing to be noted is the extreme rarity of *single* fibrillæ, most of those so appearing under a power of 400 diameters, are now seen to be composed of bundles, oftenest of two, sometimes of more fibrillæ. Here and there a single undisturbed fibrilla is however seen, the appearance of which is given in Figs 7 and 18c. Rectangular sarcous elements, their longitudinal axes rather the longer, and between which a pale translucent material is interposed, lie in a regular series; the intervening spaces measuring less than half the length of each sarcous element. The next point is this, that instances occur (several it may be in a single specimen) of sarcous elements separated from each other by spaces which are *more than equal* to the length of each element, and this may be seen in fibres, pieces split from fibres, bundles of two or three fibrillæ, or lastly in isolated fibrillæ. Close observation shows that this condition is due to stretching; and in fact, all muscular tissue in fine microscopic shreds, is in one of the two definite conditions, stretched and unstretched. To explain and prove this, I have figured a fortunate example (Fig. 18) in which manipulation has stretched an isolated double fibrilla; one-half has given way and curled up, the rest is tense and shows a totally different structure. I have stated above that bundles of fibrillæ appear as single ones under 400 diameters, and now it will be understood how this may happen; a bundle of two or more being stretched, the apparently simple sarcous masses are elongated, the interposed spaces widened out, and the once broad bundle assumes the relative proportions of a single fibrilla. [Compare Fig. 7 with 18 b. and 20.] We may next observe, that in stretched fibres there appears a transverse line which crosses the interposed matter half-way between the

* It may be well to observe, at the risk of tedious minuteness, that if Goadby's fluid be employed, as by Mr. Lealand, and the stratum chance to be thick, there are very few high angled objectives which will "correct" for so much refraction as then takes place.

adjacent sarcous elements. This line is not seen in unstretched fibres, and can only be understood by examining it in a single, or at most, double fibrilla, when it clearly appears as formed by a minute oblong mass with its long axis at right angles to that of the fibres (Fig. 17). In a double fibrilla there are two such bodies side by side, and into these the interposed line may be resolved (Fig. 20). In a fibrilla which is not stretched we must of course believe this interposed particle to be present, though concealed by the proximity of the sarcous elements.

So much for the transverse interposed "lines;" they are not lines, and it is equally erroneous to call them smaller sarcous elements alternating with larger ones; for, on the one hand, they appear as lines under a low power only, and, on the other, they do not appear in recent muscle, but only in fibre which has been long dead, or is hardened by certain reagents. Although they may appear, when very distinct, and especially in fibres taken from lower classes of animals, like intermediate sarcous elements,* I do not think it right, for the reasons just given, to rank them as equal or similar to the other particles. The last point of structure is, that in stretched fibrillæ, there is an *interposed grey matter* visible as well as an interposed particle (Fig. 17). The particle lies across the middle of a delicate stretched band, extending from one sarcous element to its neighbours, above and below. It is difficult to demonstrate this in many cases, and much more so in Goadby's than in a less highly refracting fluid. For years I failed in seeing any bond of union between the sarcous elements in a preparation of Mr. Lealand's, and was much perplexed by the question, how the particles maintained the linear arrangement. A preparation of my own (Fig. 17), in dilute spirit, showed the whole so easily that I was thus led to see the interposed band in the former preparation. It requires slightly oblique light, striking the fibrilla at right angles, and necessitating a very high "correction," the extent of which Messrs. Powell and Lealand specially increased for me in the $\frac{1}{12}$th.

The stretched fibrilla, as now described, furnishes the key to all the varied appearances which have been figured. It is a revelation of the structure of all fibrillæ, though, of course, by the stretching, all the relations are altered for the moment: thus, in Fig. 18, the fibrilla *a*, is a sort of explanation of the state of *c*; for, though this appearance cannot be produced by stretching a perfectly recent fibrilla, it may be so produced in muscle a long time after its death, indeed, as far as I know, for an unlimited time, provided only that the reagents have not

* Notes on Kölliker, by Messrs. Busk and Huxley.

rendered the interposed matter brittle. This, then, is the ultimate structure of muscle, and of the highest kind of muscle in all animals. With this type in our mind, we see the meaning of appearances readily made out and often figured, as in insects (Leydig), crustaceans (Kölliker), reptiles (Busk and Huxley), fishes (Bowman). The appearances described by Amici may be explained thus: in his paper,* after describing the fibre of a meat-fly, which he, along with many others, persists in believing to be a "fibrilla," he proceeds to figure the "fibrilla" of the lamb (Fig. 1). The dark spaces are composed of rods, the lines crossing the light spaces of dots, which express, he says, the "annestatura" of these rods. The fact is, that he was looking at a delicate *fibre*, stretched so as to lengthen out all its elements, make it very narrow, and show the interposed particles, though not the uniting material.

Again, there are often transverse lines to be seen, sometimes crossing the dark squares centrally, sometimes at each end (Fig. 9). Both these lines of darkness are optical, and may be varied at will by focal adjustment. They arise from the form of the stretched sarcous element, which easily becomes narrowed at its centre, and approaches slightly to the dumb-bell shape. As before stated, there are almost always two or more side by side in "a fibril," and so the apposed thinner centres, or thicker ends, produce a dark line across the corresponding part of each sarcous element. A side-line (Figs. 2, 3, 8, 16) is constantly present if the fluid be highly refracting and the glass undercorrected: thus Fig. 19 is carefully drawn from the fibrilla *a*, Fig. 18, with a lens purposely undercorrected and accurately focussed. That this is the true explanation appears from the circumstance that a similar dark line bounds a narrow halo around all objects or granules present by accident near the fibrilla, while correction of the lens removes the lines at once.

A subject on which I speak with considerable reserve, is that of the polarizing property of muscular tissue. Brücke has stated,† and his view seems to have obtained extensive credence, that each sarcous particle is a uni-axial, positive, polarizing body, the optic axis of which is longitudinal. This body is formed of minuter ones still—"Disdiaklasten," to which he ascribes the primary polarization. To some extent I have repeated his experiments on my own specimens, using mica stages and condensed light from an achromatic prism, but cannot at present agree with his conclusions. I always found

* Il Tempo, Giornale ital. di Medicina. Firenze, 1858.

† Sitzung's Berichte der Wiener Akademie. Juliheft, 1837.

the ray depolarized, much as he describes, by sarcous elements, *when they were compound* (Fig. 20), and more so as they were more compound. Single fibrillæ never had any affect, and I think that, like Amici, he was working with a bundle of many fibrillæ. In such a structure regular translucent masses of definite form are superimposed on other similar ones, and it seems quite intelligible that the whole should depolarize very powerfully as does the entire or broken fibre.

With reference to the sarcolemma, it is surprising how indistinct this structure is in the best developed fibres; indeed, in a long course of observation, it is more often invisible than the reverse. The assertion has been frequently repeated of late that nuclei occur not only on the inside of the sarcolemma, but also centrally amongst the fibrillæ: these I have never succeeded in finding. Their presence in or near sarcolemma is in by far the greatest harmony with the facts of development. I have already stated, in a previous paper on Connective Tissue, that the muscular fibre results from elongation of, and subdivision of nuclei in, a single embryonic cell, the wall of which developes into sarcolemma, while the sarcous contents are being laid down, and that no fusion of cells in a linear series ever takes place.

The question of "discs" as against "fibrillæ," is more interesting to the physiologist than might be supposed from the summary way in which most English, and polemical way in which most German, writers dispatch it. The histology of muscle is far in advance of its physiology, and the latter science requires to deal with the subject in every possible aspect. Discs, to which Mr. Bowman attached an importance, which all subsequent critics have been unable to destroy, have to my mind a deep physiological significance. During contraction of part of a fibre the transverse lines approximate, and so the discs (whether those of the sarcous particles or those of the interposed substance) can act as independent structures, which fibrillæ never do; a fibrilla, as such, does nothing. Add to this the almost obtrusive similarity of the whole structure to that of a voltaic pile, and it must be confessed that, though isolated discs and fibrillæ are the immediate results of cleavage force, the existence, especially of the former, must never be left out of sight.

Lastly, it may be fairly asked, "how *explain* the structure asserted to be that of a single fibrilla, as seen in Fig. 7, or Fig. 17?" To do this fully would, however, require more chemical knowledge of muscle than we now possess. The main fact is this: the bright, semi-fluid substance interposed between

the sarcous elements, is composed of two substances, each of which is capable of assuming a solid form. This happens in natural maceration of muscle, at all events in Crustaceans, and in higher animals under the influence of certain preservative solutions. In the ordinary, undisturbed state of fibrillæ, this change is accompanied only by a contraction and diminution of the interposed spaces, nothing being seen of the two elements separately. If, however, a fibre or fibrilla be stretched, the two elements become evident; the one a small transverse body, *coagulum;* the other an elastic, and, under the circumstances, extended band. It has appeared to me, that reagents which tend to coagulate albumen increase most the tendency of muscle to split into fibrillæ; but that, *if concentrated* (strong spirit, some acids), they prevent the isolation of fibrillæ; and, according to the view just advanced, by rendering brittle that pale clear band which represents the only ultimate link between all the adjacent masses of Syntonin.

SOME OBSERVATIONS ON THE ULTIMATE DISTRIBUTION OF NERVES, AND ON THEIR ORIGIN IN NERVOUS CENTRES.

By Lionel S. Beale, M.B., F.R.S.

1. *General Observations on the Peripheral Distribution of Nerves.*

The observations detailed in my paper "On the distributions of nerves to the elementary fibres of striped muscle,"* led me to conclude that the ultimate branches of the nerve-fibres formed a network on the surface of each elementary fibre which was intimately connected with the sarcolemma. This terminal network is composed of delicate flattened fibres which exhibit a granular appearance. Connected with these fibres at short intervals are oval nuclei which take part in the formation of new nerve fibres, and are probably the organs by which the nerve fibres are brought into relation with the muscular tissue.

Kühne has recently published a memoir on the same subject, and arrives at the conclusion that the nerve fibres *terminate* in the oval bodies I have described, and which were formerly considered to be nuclei of the sarcolemma. In his drawings, nuclei are represented in the course of the fibres, but each fibre is made to end in one terminal oval nucleus or corpuscle beneath the sarcolemma. Kühne's former researches

* Phil. Trans. 1860.

are referred to in my paper. Setting aside minor points of difference, the main question at issue is this:—Do nerves terminate by free extremities on or in the muscular fibre, or do the finest branches form a network so that there is no true *termination* to the terminal branches of each individual fibre?

The conclusions of most observers are certainly in favour of the former view,—and not only as regards the distribution of nerves to muscle,—for it seems to be a general opinion that the ultimate nerve fibres end, so to say, in or upon the tissue to which they are distributed. Some hold that nerves terminate in pointed or club-shaped extremities; and other physiologists consider that they pass into the tissue and perhaps become continuous with some of its elements. In some organs, nerves have been traced into structures resembling epithelial cells.

The opinion that a nerve fibre commences in a nervous centre, and after perhaps a circuitous course, terminates in the tissue, seems generally accepted, although there is much difference as to its precise relation to the vesicle at its central, and to the elements of the tissue at its peripheral, extremity. It is supposed, in the case of motor nerves, that the motor impulse starting from the centre passes along the nerve fibres, and exerts its influence upon the terminal branches; and that in the case of sensitive fibres, impressions are conveyed in an opposite direction towards the nervous centre. This inquiry as to the origin and termination of nerve fibres, it need hardly be said, is a most important one, for it involves much more than the mere anatomical question. The view we are led to take as to the nature of nervous action generally, will be much influenced, if not determined, by the conclusions arrived at with reference to the origin and distribution of the nerves. I propose, therefore, in the first place, to offer some very general remarks upon the results of my investigations, and then to describe in detail, with the aid of drawings, the distribution of nerve fibres to particular tissues both in man and animals.

The conclusions at which I have arrived from actual observation are in some respects singularly opposed to those generally entertained.

The specimens upon which my views as to the termination of nerves in muscle were founded, more than two years ago, still exhibit the appearances I have described, and almost all the statements I have to make result from observations upon specimens which can be examined by any one interested in the questions at issue. Since 1860 I have examined several other specimens of muscular fibre of man and the lower animals, and have not seen any appearances which lead me to doubt the

correctness of the conclusions at which I then arrived. Nerves distributed to muscular fibres always form a network, and I have never been able to find *terminal* fibres, as have been figured by Kölliker, and very elaborately by Kühne in his memoir just published.

Many observations have been made upon the distribution of nerves upon sensitive surfaces, and in all cases I have demonstrative evidence of the existence of a network. The nuclei connected with the fibres of the network divide, and thus new fibres are formed, while some of the old ones degenerate and leave delicate fibres of connective tissue, which still remain in connection with active nerve fibres.* The course of the fibres of this network is very complicated and the fibres are continually changing the plane in which they ramify. It is difficult to trace an individual fibre, and many of the finest fibres exhibit appearances which lead to the inference they are not single separate fibres. They vary much in diameter. Most of the fibres to which I allude are less than the 1–20,000th of an English inch in diameter, and are well defined by my twenty-sixth of an inch power. In some cases there is reason to doubt that fibres which are under the 1-50,000th of an inch, are actually single fibres. I shall discuss this subject in a paper on the Anatomy of Nerve Fibres at their distribution in the next number of the Archives. The fibres of this network do not anastomose together after the manner of a capillary network, but it seems to be formed by a vast number of distinct fibres, not one of which can be traced for any distance. Two or more fibres may run parallel to one another for a short distance, diverge in different directions, and each run parallel with a new fibre. These again soon separate as before, and pass on with other fibres. It is, therefore, much easier to give an idea of the arrangement of this network by a drawing than by description.

In no case have I been able to trace a separate fibre to this terminal network. The terminal network is connected with fibres forming, so to say, coarser networks, and these are formed by the division of bundles of nerve fibres. At the points where even the finest trunks give off branches, the same fact so constant with regard to the large compound trunks is observed, viz., that the branches are seen to pass in opposite directions, as if some fibres passed towards the periphery, while others passed towards the centre; just as in the case of the roots of the spinal nerves, as described by Lockhart Clarke, some fibres seem to pass downwards while others pass upwards towards the

* On the relation of nerves to connective tissue, see my lecture on the Anatomy of Tissues, Archives, p. 109—113, of the present volume.

brain,—and in ganglia, where fibres from the same point are seen to run in opposite directions.

I have never seen a papilla (skin, tongue, fauces, &c.,) either in man or animals in which I could feel sure only one fibre existed, while there is no difficulty in finding papillæ supplied by two or more fibres. On smooth surfaces, amongst the fibres of involuntary muscle, as of the bladder and intestines, in the peritoneum, on the external surface of arteries, beneath the skin and mucous membranes, in the periosteum, in the cornea, and other tissues, the existence of a nervous network has been demonstrated.

The conclusion from these facts is, that the fibres connected with every peripheral oval body or nucleus, pass in two different directions, and that therefore there is *no termination to the nerves in the sense in which this word is usually employed.*

The Pacinian corpuscle will doubtless occur to the reader as a structure in which the nerve fibre may be seen to terminate, but several specimens which I have prepared of these beautiful organs, demonstrate an arrangement different to that generally described, and show that immediately around the so-called axis cylinder there is a tissue which possesses a peculiar structure. The lobes into which the axis cylinder divides, turn down and are continuous with some of the nuclei connected with the capsules, but it is useless to attempt to describe the arrangement without the aid of careful drawings, and the subject must therefore be considered separately.

2. *General Observations on the Origin of Nerves from Centres.*

In the next place, as to the origin of nerves from nervous centres. The opinion that vesicles may influence fibres which are not distinctly connected with them in structure, seems to have been generally accepted. It has been stated that some vesicles are not connected with any fibres at all, that others give off a single fibre (unipolar cells), that some give off two (bipolar cells), while from other vesicles a great number of fibres radiate in different directions (multipolar cells). Most observers describe these essentially different arrangements in the nervous centres, and many others which, like them, involve different principles of action, have been pointed out by anatomists; but more exact observation, or stronger evidence derived from experiment, than has yet been obtained, is required, before we can accept the conclusion that the relation of a nerve fibre to its vesicle or cell may be so different in different organs, or in different parts of the same organ,—that in one case the fibre

must be in bodily connection with the cell to be influenced by it, while in another, the fibrous capsule of the cell and the white substance of the nerve fibre offer no impediment to the action of the cell upon the axis cylinder which is separated from it by these thick non-conducting protective coverings.

The part of the nerve fibre surrounded with the white substance of Schwann, is invariably that which intervenes between the origin or origins of the fibre from the centre and its distribution at the periphery. This portion of the nerve fibre is *protected from* the influence of ganglion cells which it may pass, and it cannot influence any tissues which may surround it in this part of its course.

It is generally believed that the vesicles in the ganglia of the sympathetic system are enveloped in a sheath of connective tissue, and that a modified form of connective tissue (gray or gelatinous fibres) exists in considerable quantity amongst the true nerve fibres in these nerves. The mode of development of the 'connective tissue capsule' of the ganglion cells and of the fibres of 'connective tissue' has not been described, nor have the uses of these structures been determined.

In my lectures on the "Structure and Growth of the Tissues," Plate X, Figs. 65 and 66,* I have given drawings of ganglion cells, with numerous fibres continuous with them from a ganglion in the pericardium of the ox. I have shown that the fibres of the so-called connective tissue capsule are continuous with the substance of the outer part of the ganglion cell, and that the fibres in the nerve are continuous with these in every case. In fact, these fibres, which contain numerous nuclei, pass off from the outer part of the ganglion cell, and after coursing round this cell, leave it and pursue a longitudinal course in the fibre. As there are no dark-bordered fibres (fibres with the white substance of Schwann) in relation with many of these ganglia, we are forced to conclude :—*either that these are not ganglion cells and nerve fibres at all, or that ganglion cells exist in immense number in relation with a modified form of connective tissue, destitute of nerve fibres altogether, or that these numerous fibres in connection with the substance of the ganglion cells are true nerve fibres,* as Remak, and Todd and Bowman, and others, formerly supposed. It seems to me that the last conclusion is the only one that can possibly be accepted. I therefore regard these as true nerve fibres, resembling in their general appearance the ultimate fibres of distribution of the ordinary dark-bordered nerve fibres. In favour of this view I have a great number of observations.

* See also Plate IX, fig. 40, of the present Volume.

In the *multipolar* ganglion cells, it is clearly possible that some fibres should establish communications with other cells, while some may pass to the periphery, and others pursue a long circuitous course, and at last join nervous centres in different parts of the body. A similar arrangement is possible in the case of the *bipolar* cells, if the fibres divide into several branches at a short distance from their origin from the cell. The existence of a cell with *only a single fibre* proceeding from it, seems in favour of the view, that a single fibre may arise from a centre and pass to its point of distribution. But it is very difficult to demonstrate the fact that but one fibre leaves the cell. I have many specimens in which the fibres are so very fine and delicate, that they are only visible in fortunate specimens which have become very transparent by long immersion in glycerine. In many cases where ganglion cells appeared destitute of any fibre whatever, I have succeeded in demonstrating the existence of several arising from different parts of the cell, and many observations have led me to the conclusion that it must be very difficult to prove the absence of fibres in connection with the nerve cells. My own conclusion is, *that all nerve cells without exception are connected with or pass into fibres, and that there are no free nerve cells whatever.* In large insects, it is possible to demonstrate, by using the 1–26th, very fine fibres coming off from different parts of ganglion cells; while in small insects the ganglia may be seen, and the cells demonstrated, but the fibres coming from them are too fine to be visible. Yet in such a case as this, the evidence in favour of the existence of the fibres is perfectly conclusive and incontrovertible, though they may for ever remain invisible to us. If we do not accept this conclusion, we must be prepared to maintain that the movements of a small fly, for example, depend upon a mechanism totally different to that which can be actually demonstrated in a species of the same genus or class of much larger size.

I shall give drawings of flask-shaped nerve cells from the frog, which appear unipolar, but from every one of which at least *two distinct* fibres arise. Not only can these be demonstrated in almost every cell, but the fibres arise from different parts of the cell,—one from the central part, and the other from the circumference,—a fact of great interest and importance.

Inferences from the above Conclusions.

The general conclusion to which I have been led, from the careful examination of a great number of specimens, may be briefly stated thus :—that in all cases, nerves are

continuous with the matter of nerve or ganglion cells in the nervous centres, and with small masses of vesicular matter (nuclei, or corpuscles) which may be triangular, oval, or may exhibit other forms, at the periphery. It is only through the influence of these bodies that nerves can be brought into relation with any tissue, and these are the structures upon which the growth, multiplication, and repair of the fibres at their distribution alone depend.

I shall bring forward many anatomical facts which seem to me to render it very probable, that a fibre passing *from* a cell in a nervous centre returns *to* the same cell. Its course may be very long and circuitous, and it may have numerous connections with other cells and fibres in different parts of its course, but still a complete and uninterrupted *circuit* exists. Within this there may be, so to say, smaller circuits. Every cell probably forms part of a circuit, and is invariably connected with other cells by fibres which pursue opposite directions. When a fibre grows it does not *shoot* out from the cell and spread outwards into the tissues, but the cell, or rather its germinal matter, divides, the new mass remaining in connection with the original one by fibres formed at its two extremities. This process is continued until many new fibres and nuclei result. At the same time the elements of the tissue around the nerve fibre are growing, and the peripheral nuclei become separated farther and farther from the centre from which they originated, but remain in connection with it by at least two fibres. These inferences are derived from actual observation of structure. One may perhaps be pardoned for offering, in very few words, crude suggestions as to the office of the structures described, for it is impossible to study the structure of a tissue or organ without speculating upon the manner in which the mechanism may act during life. Any disturbance taking place in the composition of the substances entering into the formation of cells, or elementary parts, must be accompanied by electrical disturbance, but it is only in the nervous system that we find an arrangement by which these currents may influence distant parts, where they may effect many changes and may excite new disturbances. The existence of a network of delicate nerve fibres around every elementary fibre of voluntary muscle almost necessarily leads us to the inference that muscular contraction is due to a polar state of the nerve fibres which encircle the muscle, momentarily induced by electricity or by the manifestation of some force closely allied, and perhaps correllated, to it, the development of which is due to physical changes occurring in central or in central and peripheral nerve-cells. The

musclar contractions commence at the points where the terminal branches of the nervous network cross the elementary fibre.

I shall now proceed to describe in detail some of the anatomical points which appear to me to justify the view which has been very roughly indicated.

On Selecting Tissues for Demonstrating the Arrangement of the Distribution of the Terminal Branches of Nerve Fibres.

In attempting to demonstrate distinctly the arrangement of the ultimate branches of the nerves distributed to different tissues, we meet with certain difficulties which are peculiar to investigations upon the structure of the peripheral nervous system. Besides the ordinary difficulties arising from the softness and extreme delicacy of the nerve tissue, and its tendency to disintegration very soon after death, it often happens, that the finest branches of the nerves are embedded in a tissue which is so fibrous and opaque as to prevent them from being seen, or the refractive power of the tissue is such that delicate structures existing in it are invisible. It is obvious that we shall not meet with success unless the sections of tissue examined be extremely thin. In attempting to make such sections with a knife, the relative position of the various structures must necessarily be considerably changed, and in too many instances the nerve fibres present are so altered that their nature cannot be recognised, and, although by certain processes of hardening the tissue, this difficulty is to some extent surmounted, it too often happens that new sources of error arise from the action of the chemical solution employed. In thin sections, obtained under the most favourable circumstances, several segments of different nerve fibres varying much in length, can only be obtained; the longest of them is seldom more than the 1–100th of an inch in length. This arises from the fact that the terminal branches of the nerve fibres frequently change the plane in which they run, so that an individual fibre can be traced for a very short distance only. Although from facts observed in well-prepared sections, an inference may be drawn, which is probably very near the truth, it must be admitted that a conclusion so arrived at is not equivalent to a demonstration, and it may reasonably be required of anatomists, that they should be able to prepare a specimen in which the course of one or more individual fibres can be actually followed from where the dark-bordered fibre is seen, to the ultimate distribution of the fine fibres continuous with it.

Indeed, an actual demonstration of the ultimate arrangement must be obtained, before any conclusions upon this very difficult and much disputed question can be generally received.

In an enquiry of this kind, it is very important to select the tissue or organ for investigation with the greatest care, and having decided upon it, to study the tissue under the influence of different methods of preparation for a considerable period of time. In many of the tissues of man, and the higher mammalian animals, the finest branches of the nerves at their distribution are so very numerous, that it is not possible to follow an individual fibre for more than two or three thousandths of an inch, and the fibres themselves are so fine, as to be scarcely separable from each other even by the highest powers.

The large size of the nerve fibres of the frog, and the comparatively small number of branches in the different tissues of this animal render them more favourable for investigation. I propose to give drawings of the ultimate branches of the nerve fibres, in several tissues, and shall describe the arrangement of branches of motor, sensitive and sympathetic nerves. As the result of my observations are opposed to the statements of most authorities, and may perhaps be called in question, it is well for me to mention, that the particular species of frog I have employed is the common frog of this country (Rana temporaria), and not the large green frog (Rana esculenta) of the continent. All my specimens have been prepared in precisely the same way, and have been preserved in glycerine; some having been previously soaked in carmine. I shall fully describe the exact process followed in another communication. I would also remark, that my drawings are copies from nature, and were drawn upon the wood block by myself, and finished from the object. As in other cases they have been drawn to a scale. Neither must it be supposed that the appearances indicated are exceptional and not often met with. The drawings give a fair representation of the arrangement generally observed. The greatest care has been taken in preparing the specimens, and many hours have often been spent upon a single preparation. Moreover, as my specimens are preserved permanently, they have been frequently examined during the last three years, so that my conclusions upon the arrangement of the nerves in any special tissue have been compared with those arrived at in the investigation of other tissues. The enquiry has been undertaken quite independently of any physiological views, and my drawings only represent what has been seen by myself, and what I have shown to other observers.

Bladder of the Frog.

The large vesicle, usually termed the bladder, connected with the cloaca of the frog, consists of an exceedingly thin membrane, composed of several different tissues. At its upper part it is of such extreme tenuity, that all its component structures can be seen, without making a section, with the highest powers. Connective tissue, vessels, nerves, organic muscular fibres, and epithelium can all be demonstrated. In the specimens I have preserved, the vessels have been injected with Prussian blue, and their nuclei, as well as those of the muscular fibres and nerves, have been coloured with carmine. I have some pieces which can be examined with the 1–26th of an inch object glass. The different structures lying on various planes can be brought into focus one after the other, and the delicate nerve fibres can be readily followed amongst the muscular fibres, and upon the surface of the mucous membrane. Fig. 6, Pl. XVII.

Connective Tissue.—Upon the external surface of the membrane are seen some fibres of connective tissue, some of which consist of large branching cylindrical bundles, which increase considerably in thickness and number towards the lower part of the organ. The general description of such fibres has been given on page 77 of the present volume of the Archives. There are also many finer fibres of connective tissue ramifying amongst the other tissues which enter into the composition of the membrane.

Muscular Fibres.—The muscular fibres, or muscular fibre cells, as they have been termed, are exceedingly delicate, and their arrangement is very beautiful. The ordinary elongated spindle-shaped fibres arranged in bundles around the vessels preponderate, but in the sacculated intervals between these bundles, where the membrane is very thin, much finer muscular fibres are seen. Many of these have three or four processes which diverge in opposite directions. The very thin fibrous extremities are gradually lost in the neighbouring bundles, or fade into a very transparent matrix (connective tissue). It seems to me that these processes are not tubular as has been maintained by several authors, and that therefore we cannot look upon them as spindle-shaped cells. In these beautiful contractile fibres there is no appearance which indicates the existence of a cell wall. The fibre gradually diminishes in thickness from its thickest part where the nucleus is situated, to the thinnest possible fibre. It is probable that the power of contractility does not exist in the thinnest part, which has become resolved into

mere fibrous tissue. This part of the fibre was that which was first formed, and when the fibre was young it possessed contractile power; but as new contractile tissue was developed between this part of the fibre and the nucleus, condensation occurred, and this, the oldest, portion gradually assumed the character of ordinary tendon.

Vessels.—The arrangement of the vessels and the development of new branches can be studied very successfully in this membrane, but this part of the subject cannot be considered here.

Nerves.—Near the base of the bladder very many dark-bordered fibres exist. Some can be followed for a long distance as single, separate dark-bordered fibres, but many bundles which form a network with wide meshes are also present. The fibres composing these bundles divide here and there, and the subdivisions, after taking part in forming other bundles, may be seen to subdivide again. Over the general surface of the bladder fine dark-bordered fibres can be followed for some distance. They are not numerous, and considerable intervals exist, which seem to receive no nerve fibres at all. The dark-bordered fibres gradually become thinner as they divide and subdivide, and the last subdivision often occurs at a point only a short distance from where the fibre seems to end. Many of the dark-bordered fibres, after gradually diminishing in diameter to about 1–10·000th of an inch, appear to terminate almost abruptly. Sometimes they become slightly tapered before they end. Very often a pale fibre, in immediate continuation with the dark-bordered fibre, can be traced for a short distance beyond the point at which the former seems to cease.

So far then the conclusion would be formed that the dark-bordered fibres were very sparingly distributed to the fundus of the frog's bladder, and terminated in free extremities, or by becoming continuous with, or lost amongst, the tissues to which they were distributed; and it would be inferred from this observation that the tissues entering into the formation of the bladder received but a very sparing supply of nerve fibres at all.

In portions of this same tissue which had been kept for some time in glycerine, to which a few drops of acetic acid had been added, a very much more elaborate arrangement of the ultimate nerve fibres was discovered. Although the distribution was very much more extensive than was at first supposed; the general conclusion which has resulted from these and other observations

with regard to the ultimate distribution of the nerves, is very much more simple than that which is commonly entertained. The appearances also afford an explanation of many points which have not been hitherto satisfactorily explained.

The arrangement I have demonstrated in these specimens seem to me to be fatal to the doctrine of free ends now so generally entertained. All over the field delicate fibres are observed which form networks, the meshes of which vary much in size. The fibres which form these networks are not single, but composed of bundles of very much finer fibres, and they contain nuclei situated at short intervals. The delicate fibres do not therefore anastomose to form rings, but the fibres of a bundle divide into parcels which pass off in different directions, and divide into other parcels which mingle with fibres resulting from the division of bundles coming from different parts of the tissue. Fig. 2, Pl. XV. At short and not very regular intervals oval or triangular nuclei are observed *a*, *b*. Some of the fibres are connected with the nucleus, and others pass by it. Not unfrequently a fine bundle of fibres passes on one side of the nucleus without being attached to it. Fig. 9 *c*, Pl. XIX. Many of these compound fibres were so fine that they were hardly visible when the 1–26th was used, but there is reason for believing that even these are not single fibres, for wherever such a fine fibre comes in contact with a branch passing at right angles, it is seen to divide into two finer fibres, which pursue opposite directions. Fig. 1, Pl. XV, at *a*.

These very fine fibres are found upon the surface just beneath the epithelium, and also amongst the muscular fibres, in great number. Fig. 2 represents a portion of the network upon the surface of the mucous membrane, just beneath the epithelium which has been removed. The fibres are not quite so numerous over the whole surface as in the part which has been figured; but everywhere fibres forming most distinct networks or plexuses exist. This figure is magnified 1,700 diameters.

As I have already stated the dark-bordered fibres become gradually finer as we approach what appears to be their termination. Perhaps for the distance of the 1–200th of an inch from what appears to be the end, the white substance varies much in thickness, and by the action of acetic acid, globules are displayed; but the fibre often becomes very thin at the point where it appears to terminate. Figs. 5, 6, Pl. XVII. From this point a pale fibre can be traced, which often divides and subdivides. The fibres resulting from the division pass with other pale fibres, and assist in forming the network already described. But in truth, the pale fibre continuous with the dark-bordered

fibre consists not of a single fibre, the continuation of the axis-cylinder as is generally inferred—but of a bundle of very fine fibres. Figs. 3, 4, 5, Pl. XVI.

In specimens which have been acted upon by acetic acid, the distinction between the dark-bordered fibre and the pale fibre in continuity with it is not so well marked, and a chemical change is produced in the dark-bordered fibre, precisely resembling that which has been described as having occurred in the pale fibres.

It is not possible to distinguish the white substance and the axis cylinder as distinct structures in the dark-bordered fibres near their continuity with the network of fine fibres, by any of the processes of preparation I have tried. Although this distinction undoubtedly exists in the trunks, I believe that near the termination of the dark-bordered fibre,—that is, near the commencement of the active part of the nerve fibre, the white substance and the axis cylinder are incorporated. Acetic acid acts upon the pale fibres in precisely the same way as it acts upon the terminal part of the dark-bordered fibre; in both cases, globules having the same general appearance and refractive power result. I conclude therefore that the terminal part of the dark-bordered fibre possesses the same general structure and chemical composition as the pale fibre.

The continuity of the pale fibres with the dark-bordered fibres, and the manner in which the network of pale compound fibres is formed, is well seen in the three figures in plate XVI. The mode in which the very fine fibres *a* running in the same sheath with the dark-bordered fibres, also enter the network of pale fibres is represented. These fine nerve fibres are very common in the sheaths, not far from the point where the dark-bordered fibres cease.

The very fine fibres are not visible in specimens prepared by the ordinary method, nor is it possible to see them in specimens of the very same membrane which have been preserved in aqueous fluids, nor in any which have not been subjected to the prolonged action of dilute acetic acid. The acid decomposes the material of which these fine fibres are composed, setting free fatty matter, which is readily distinguished by its high refractive power. These fine fibres, which in ordinary specimens are not visible, have not, I believe, been before figured or described. Many observers have traced pale fibres a short distance beyond the point at which the dark-bordered fibre seemed to terminate, but they were gradually lost, or it was inferred that they terminated in fine pointed extremities. But the existence of a network of very fine pale fibres (Plates XVI, XVII, Figs. 3, 4, 5, 6),

directly continuous with the dark-bordered fibres, is not the only important fact domonstrated in my specimens.

Very fine fibres, exactly resembling those of which the network is constituted, are seen accompanying the dark-bordered fibres, often running close beside them, and apparently in the same sheath. Pl. XVI, Figs. 3, 4, 5 *a*; Pl. XIX, Fig. 10. I have already mentioned that the tubular membrane does not exist as a sheath round each dark-bordered nerve fibre near its termination; but this structure seems to be represented by a transparent matrix in which several dark-bordered nerve fibres, varying much in diameter, are embedded, and amongst these some of the very fine fibres above described are seen. These fine fibres often run so close to the dark-bordered fibres, that in specimens mounted in aqueous fluids they are invisible as distinct structures, in consequence of being obscured by the dark line caused by the difference in refractive power of the white substance and the medium in which it is immersed. It is only in specimens mounted in glycerine or syrup that these appearances can be demonstrated.

What appears to be the outline of the tubular membrane of a dark-bordered fibre is often caused by the presence of one or more fine fibres with their nuclei. Very frequently such fine fibres are found upon one side only of the dark-bordered fibre (Fig. 10, Pl. XIX), and fine branches may come off from them, cross the dark-bordered fibre, and diverge from its course altogether. I have often traced a fine fibre running parallel with a dark-bordered fibre for some distance, and have seen it gradually increase in diameter until it became an ordinary dark-bordered fibre. The bundle of fine fibres into which the dark-bordered fibre is resolved, and which also receives the fine fibres ramifying in the sheath just described, is often as wide and sometimes wider than the dark-bordered fibre itself. It would seem as if the fine fibres were spread out, and therefore occupied more room. The united area of the fine branches is, of course, much greater than the area of the trunk from which they proceed.

Not only are fine pale fibres found accompanying the terminal portions of the dark-bordered fibres, or ramifying a short distance from them, as well as forming the extensive network already described; but there are numerous pale fibres in the frog's bladder as much as the 1–10,000th of an inch in diameter, or even more, which are composed entirely of numerous very fine fibres: these ramify alone, and are not accompanied by dark-bordered fibres. I have seen plexuses too consisting of such fine fibres alone. I have specimens in which

some such plexuses exist as much as the 1–500th of an inch in diameter. They are composed of more than 100 very fine fibres crossing each other in different directions, and assisting to form compound fibres, which leave the plexus at different points, and pursue different courses. Fig. 1, Plate I, vol. iv, represents a good specimen of one of these plexuses.*

To sum up:—The dark-bordered fibres distributed to the frog's bladder, after dividing and subdividing as has been described, terminate in a network of very fine fibres. Connected with which network are also fine fibres, which are not immediately continuous with dark-bordered fibres, but which may be traced for a considerable distance forming trunks, some of which run with the dark-bordered fibres, while others pursue a course by themselves. The question of function of these fibres must be discussed separately.

There is, then, as it were, beyond what appears to be the termination of the dark-bordered fibres, a most extensive net-work of pale fibres, ramifying everywhere upon the surface of the mucous membrane, and amongst the muscular fibres. The general arrangement of the first or sensitive fibres, and the last, or motor branches, is the same, but the meshes of the networks amongst the muscular fibres are much wider than those on the surface of the mucous membrane. The fibres of these networks would be called pale fibres, but, as I have shown, each apparent fibre consists of a great many fibres, many of which must be less than 1–100,000th of an inch in diameter. These bundles of fibres are quite invisible in ordinary specimens. The peripheral portion of the nerves in this tissue is, therefore, much more extensive than is generally supposed, and the tissues are brought into relation with the nerves at very short intervals. The dark-bordered fibres are probably merely cords of communication between the peripheral nerve-cells and fibres, and the vesicles of the nervous centre.

Of the Distribution of Nerve Fibres to the vessels of the Frog's Bladder.—Pale fibres exist in considerable number around the smallest branches of the arteries of the frog's bladder, and branches can also be traced to the capillary vessels, but I am unable to say if these vascular branches are derived from special nerves, or from those trunks which also supply the muscular fibres. Certainly, the branches distributed

* This plate will be published in No. 13 of the "Archives."

to the vessels commingle with those ramifying amongst the muscular fibres in such great number; but it is not possible for me at present to form any positive conclusions as to the central distribution of the fibres which leave the network I have described. Is is, however, certain that there is not one network of fibres for the mucous surface, another for the muscular fibres, and a third for the vessels, distinct from each other, each connected only with its own special trunks, but the fine fibres forming the branches of the networks, probably have different functions, and are really distributed ultimately to their own proper tissue only. Fibres which are to be distributed to the mucous membrane, may ramify for some distance with those distributed to muscular fibres or to vessels, so that if a compound fibre were divided, we should not completely paralize one tissue only, nor one circumscribed portion of all the tissues which the fibres supplied, but fibres whose ultimate destinations were perhaps wide apart, would be affected by the injury. The nervous supply of the different tissues, would be slightly affected, but in no one spot would there be a complete destruction of all the fine fibres.*

I hoped to have been able to describe in this place, the arrangement of the nerve fibres in the mucous membrane of the palate of the frog, for the appearances observed here help to explain some of those before mentioned, and others which will be alluded to presently; they also confirm the conclusions arrived at in the course of other enquiries on the peripheral distribution of the nerves. Several of the drawings have not yet been completed, so that the paper must be published in a future number of the Archives.

The Distribution of the Nerve Fibres to the Mucous Membrane covering the Epiglottis of the Human Subject.

The mucous membrane covering the epiglottis was selected as a tissue favourable for investigating the distribution of the finest nerve fibres in a sensitive tissue of man. The mucous membrane adheres to the cartilage beneath very firmly, and in consequence of this, after the tissue has been somewhat hardened, very thin sections could be readily obtained with a sharp knife. The

* Some of the nerve fibres distributed to the capillary vessels are represented at Plate XVII, Fig. 5. See also my paper "On the Distribution of the Nerves to the Elementary Fibres of Striped Muscle." Phil. Trans. 1860, Plate XXIII, Figs. 5, 9.

epiglottis, removed a few hours after death, was soaked in carmine solution, and afterwards in glycerine, to which a little chromic acid had been added. Otherwise, the mode of preparation was precisely the same as was adopted in other tissues. When the mucous membrane was in a state favourable for investigation, the epithelium was removed from a portion of the convex surface, and several thin sections, as thin as could possibly be obtained with a very sharp thin knife, were cut off from the subjacent tissue. Thus sections were obtained, which included certain portions of the mucous membrane, at various depths below the surface, as well as a portion of the deepest layer of the epithelial cells. The specimens were placed in glycerine, and subjected to very gradual pressure, until they were sufficiently thin for examination with the highest powers, including the 1–26th of an inch object-glass. The best sections thus obtained have been preserved, and although made in 1860, several still exhibit their most important characters. (October, 1862.)

In the deeper layers of the mucous membrane, connective tissue, in which coarse fibres of the yellow element greatly preponderated, existed in considerable quantity. Here and there were seen large bundles of dark-bordered nerve fibres, which were divided in different directions by the knife; above this, the yellow elastic tissue was finer, and the fibres more numerous. The nerve fibres also existed in greater number, but the bundles and individual fibres were finer and closer together; still nearer the surface, the elastic fibres were fewer in number and much finer, while the nerve fibres formed flattened bundles, in which numerous nuclei were observed, which interlaced with each other in various directions, and almost formed a thin nervous expansion. The fibres were much finer, and more numerous than at a point below, and no doubt resulted from the division and subdivision of the larger fibres, of which the bundles already referred to were composed. These fine interlacing fibres are not the terminal branches of the nerve fibres. Above these, and immediately beneath the epithelium, numerous very delicate fibres, with nuclei were seen branching in every direction. Divisions of these delicate fibres were very frequent, and separate ones could be followed for a considerable distance across the field. The plane of ramification of the fibres was continually changed, so that in every section numerous small pieces of fine fibres were present. Many of the fibres contained nuclei or cells of an oval form, but some of them were triangular, and from these three fibres radiated in different directions. The fibres were seen to divide in many instances. The finest were

not more than the 1–100,000th of an inch in diameter, but I believe these consist of several finer fibres running together.

The cells or nuclei precisely correspond to somewhat similar structures in the organs of sight, smell, and hearing. "Nuclei" or "cells," with fine pale fibres connected with them, form the peripheral distribution of all nerves.*

In the specimens of the mucous membrane of the epiglottis I have never been able to detect the terminal *extremity* of a nerve fibre. It is true in these sections fibres with ends were common enough, but the ends had all the appearance of being cut. *Fibres projected from all the nuclei or cells in at least two directions*, and, from the appearances observed in many sections, I was led to conclude that this was the normal arrangement, and that from *every nerve-cell fibres passed in opposite directions*. One fibre may be regarded as passing from, and the other towards, the central nerve cell, which is thus supposed to be connected with the peripheral cell by at least two fibres.

The reader will be able to form a good idea of the appearance of the specimen if he refers to the beautiful engraving in Plate XVIII, which is, as nearly as I could make the drawing on the wood, an exact copy of the specimen.

The fine nerve fibres with their nuclei form, as has been described, an interlacement, the fibres passing in every possible direction—not in straight but in curved lines, and the curves formed exactly resemble the curves which the larger nerve fibres always exhibit in their ramifications. In the Plate, a number of very fine fibres, which are not altered by acetic acid, and resemble in their general appearance delicate elastic fibres, are represented. I regard these as altered nerve fibres,—fibres which were active at a former period, but which still remain connected with the nerve fibres, although they no longer perform any function. These fibres must accumulate as the tissue advances in age; new fibres being continually developed upon the surface just beneath the epithelium. I do not, however, mean to assert that all the fibres described as elastic fibres of the mucous membrane are thus formed. Undoubtedly, the elastic fibres, so abundant in the submucous tissue of certain mucous membranes, are formed from nuclei like those elastic fibres of the ligamentum nuchæ and arteries. As we have two distinct forms of fibrous tissue which are rendered transparent and altered by acetic

* The terms "nucleus" and "cell" have been very arbitrarily used. They mean here the mass of *germinal matter* with its investment of *formed material*. These "cells" or elementary parts are spherical, oval or triangular in form.

acid, so we have two forms of fibrous tissue which resist the action of this reagent—the one being developed as a special tissue, the other rather representing the remains of a tissue which had been in an active state at an anterior period of time.

Vessels of the Mucous Membrane of the Human Epiglottis.—The capillary vessels of this tissue are represented in Fig. 7, Plate XVII. The nuclei are very numerous, and seem to be situated in the substance of their walls. Many of them project for some distance into the cavity of the vessel. The large figure (Pl. XVIII) just described represents a space between the vessels in Fig. 7.

[*To be continued.*]

PRESENT STATE OF THE DOCTRINE CONCERNING THE INFLUENCE OF THE NERVOUS SYSTEM ON THE SECRETION OF THE GASTRIC JUICE AND DIGESTION.

By C. Eckhard, M.D., Professor of Anatomy and Physiology at the University of Giessen, Germany.

Since physiologists have been acquainted with the influence exerted by nerves on the process of secretion, especially in the case of the salivary glands, they have repeatedly tried to ascertain which nerves preside over the secretion of the gastric juice, and influence its properties as regards digestion. Knowing that fibres of the pneumogastric nerve as well as fibres from the coeliac ganglion are distributed to the walls of the stomach, both sets of fibres were made the subject of experiment. Passing over more remote and imperfect methods of research, we come first to experiments made by Bidder and Schmidt.* These observers have divided the nervus vagus at the neck (in cats and dogs), and they have noticed certain diminution of the quantity of the gastric juice as well as impairment of its digestive power. But they considered these facts as consequences of the paralysis of the œsophagus, induced by the operation, believing that a certain amount of saliva might be necessary to the secretion of a sufficient quantity of the gastric juice and its definite peculiar reaction. They founded their opinion upon the experiment, that in animals operated upon in the manner already described, and provided with fistulous openings in the stomach, the quantity of the secretion of gastric juice and its digestive power increased as

* Die Verdauungssäfte, etc., 1852.

soon as a sufficient quantity of water (the chief constituent of the saliva) was injected into the stomach. Although I considered these arguments at the time conclusive; after a time, as I had to consider this question in my course on physiology, some doubts presented themselves to me. It occurred to me that the nervus vagus, during its passage along the œsophagus, might contain some ganglia, giving origin to nerve fibres, which might be the real sources of the nerves which preside over the secretion in the stomach. These branches would escape section if Bidders's method of operation was adopted. In the year 1856, Mr. Pincus* wrote a paper, in which he endeavoured to show that after the section of the nervus vagus, the reaction of the gastric juice became alkaline. These conclusions seemed to confirm my supposition, especially as the author had performed the section of the nervus vagus precisely at that spot were I wished it to be done, *i.e.*, near to the cardia of the stomach. I therefore repeated the same experiments on the dog, but failed entirely in obtaining results above referred to. As I was occupied at that time with other researches, I recommended one of my senior pupils, Mr. Kritzler, to make this the subject of investigation for his graduation thesis. He worked in my laboratory, and published his paper in 1860.† By his researches he was led to the same result as I had been in my preliminary experiments. After the section of the two pneumogastric nerves at the cardia, he never found either the reaction of the gastric juice alkaline, or its digestive power diminished. By-and-by we devised a method of operation, which was so well endured by the animals that the wounds healed after the lapse of some weeks, and afterwards no sign of any pathological state was observed. Also we made out the cause which had led Mr. Pincus to his assertion. His method of operation, namely, had been so severe that the animals had died after some twenty hours, and the injury of the stomach had produced an alkaline fluid in consequence of slight hemorrhages and the like, which had taken place on the mucous membrane. In all cases, observed by Mr. Kritzler and myself, the dogs were killed some weeks after the operation in order to be convinced that the divided nerves had not united. Our results were corroborated by Mr. Bruecke‡ and Mr. Schiff.§

* Experimenta de vi nervi vagi et sympathici ad vasa, secretionem, nutritionem tractus intestinalis et renum.

† Ueber den Einfluss des nervus vagus auf die Beschaffenheit der Secretion der Magensaftdrüsen, etc. Giessen, 1860.

‡ Sitzungsberichte der Wiener Akademie, xxxvii.

§ Schweizerische Monatsschrift fur praktische Medicin. Jahrgang, 1860.

Now I took into consideration the cœliac ganglion, and recommended the researches about to be described to an assistant of mine, Mr. Adrian. He published his researches as a graduation thesis in 1861.* He executed the experiments under my guidance in my laboratory. The difficult research led, as the first series, upon the nervus vagus, also to negative results. I need not say that we have sufficiently distinguished between the immediate consequences of the operation itself and the more permanent ones, and that on every animal we sacrified for this research, finally a post-mortem examination was made, in order to see whether the ganglion had been extirpated in the manner we intended, or not. In this way we corrected also other views entertained concerning the functions of this ganglion, supported by Mr. Pincus. This author was of opinion, that after the extirpation of the cœliac ganglion hemorrhages and ulcers occurred in the stomach and duodenum. It would have been an important result to show that the mere want of a ganglion might produce so severe an effect. In the meantime Mr. Adrian came to the conclusion that no lasting effects of any kind are to be observed,—the slight hemorrhages and inflammation being unavoidable circumstances which follow the operation.

Result:—Neither the nervus vagus along its whole course, nor the cœliac ganglion, contain nervous fibres, which preside over the secretion of the gastric juice.

The deficiency in our knowledge as to the nerves which may influence the gastric secretions must be cleared up by future researches; still the negative results already obtained will avoid much waste of time and labour to others, and spare the lives of many poor creatures.

ON THE PROPERTIES OF THE SALIVA OF THE PAROTID AND SUBMAXILLARY GLAND IN MAN.

By C. Eckhard, M.D., Professor of Anatomy and Physiology at the University of Giessen, Germany.

Hitherto experimental physiology possessed no means to procure separately the fluids of the different salivary glands of man in the healthy state. Physiologists were obliged to content themselves with studying only the parotid saliva when Steno's duct by any accident was divided. Some years since I endeavoured

* Ueber die Funktionen des plexus cœliacus. Giessen, 1861.

to procure saliva by introducing long and thin tubes into the natural orifices of Steno's and Wharton's ducts. I succeeded first with the duct of the parotid gland, and a pupil* of mine wrote a paper on that subject in 1860. I met with greater difficulty when trying the same procedure with regard to Wharton's duct. A little exercise, however, especially in applying a thin glass tube, shaped conically at one end, has led to a sufficient process. The tubes being introduced, a profuse secretion takes place as soon as the mucous membrane of the tongue is irritated by any savory fluid. The secretions of the two salivary glands can be collected *separately* in clean glasses, and their properties studied. An examination of these two kinds of saliva has led to the following results :—

1. The saliva of the submaxillary gland is *always alkaline*, that of the parotid in *most cases*. Sometimes, especially in the morning, the first few drops of the latter are found of an acid reaction; soon however, this disappears, and an alkaline one takes its place.

2. Immediately after secretion each kind of saliva is perfectly transparent and fluid, and does not contain any cells. Very seldom, however, a few epithelial cells of the ducts are met with; but the corpuscles, so peculiar to the mixed saliva of the mouth, are never found. After a while the fluid of the submaxillary gland gets gradually viscous, and a kind of flocculent sediment is formed, whereas the parotid saliva does not change at all, or at most gets a little opaque.

3. Both kinds become opaque when heated, and even small quantities of coagulated matter are formed. By adding mineral acids, solution of the precipitate does not take place. But the quantity of this substance is too small for determining its amount or ascertaining its properties. We shall see that this principle takes part in the physiological action of the saliva.

4. The specific gravity of the parotid fluid is higher than that of the submaxillary gland, and as to the aqueous residue, we find that the same holds. The following Table shows the sp. gr. and the residues of each kind of saliva. The portions compared were collected immediately one after the other. The brackets embrace two corresponding specimens, collected under the same circumstances.

* Ordenstein : Über den Parotidenspeichel des Menschen, meine Beiträge II, page 101.

Saliva of		Specific Gravity.		Dry residue in 100 parts of Saliva.
Submaxillary gland..	....	1·0025	....	0·45
Parotid "	....	1·0044	....	0·76
Submaxillary gland..	....	1·0031	....	0·50
Parotid "	....	1·0047	....	0·79
Submaxillary gland..	....	1·0036	....	0·61
Parotid "	....	1·0061	....	0·89
Submaxillary gland..	....	1·0040	....	0·64
Parotid "	....	1·0058	....	0·92
Submaxillary gland..	....	1·0030	....	0·65
Parotid "	....	1·0042	....	0·84

5. Neither the specific gravity, nor the quantity of dry residue, change much when food is taken. The following Table contains a series of investigations made with regard to this point. It shows the changes are hardly appreciable.

Submaxillary Saliva.

Time when collected. h. m. h. m.		Sp. Gr.		Dry residues at 100 parts.		Food.
6 0 — 6 20 a.m.	..	1·0026	..	0·36	..	Not having eaten
8 10— 8 30 "	..	1·0026	..	0·41	..	anything.
9 10— 9 30 "	..	1·0033	..	0·46	..	Substantial break-
10 20—10 40 "	..	1·0033	..	0·37	..	fast at 8.5.
11 15—11 30 "	..	1·0033	..	0·44		
12 45— 1 0 "	..	1·0029	..	0·43	..	Soups and ½ lb. of
1 45— 2 5 p.m.	..	1·0029	..	0·39	..	meat at 12 o'clock.
2 45— 3 5 "	..	1·0026	..	0·36		

6. In man, each kind of saliva converts starch into sugar. As to this point there is a remarkable difference between the saliva of man and dog. In the latter, according to the investigations made by Messrs. Schmidt and Bidder, it is only the m i x t u r e of the different fluids of the glands with the fluid of the mucous membrane of the mouth, which is able to produce the change just mentioned. In man there is no doubt that the saliva of the submaxillary glands, as well as that of the parotid, acts upon the starch within a very short time. I have often tried it with the same result.

7. Both fluids loose this property when heated for a short time, whereas refrigeration to some degrees beneath zero of the thermometer, does not injure them in any way. Remembering the fact 3, we may submit that the conversions of amyloid substance into sugar, might be effected by the small quantity of albuminous matter we find in each kind of saliva.

8. Sulphocyanide of potassium I found only in the saliva of the parotid glands. In that of the submaxillary gland I failed absolutely, although I tried it at different times and on different individuals.

REMARKS ON THE RECENT OBSERVATIONS OF KÜHNE AND KÖLLIKER UPON THE TERMINATION OF THE NERVES IN VOLUNTARY MUSCLE.

By Lionel S. Beale, M.B., F.R.S.

Few questions in minute anatomy have been more carefully studied than the distribution of nerves to voluntary muscle, and within the last three years several memoirs have appeared. I propose now to refer briefly to the very recent observations of Kühne & Kölliker. A translation of Kühne's remarks on Kölliker's observations has been translated for me by Dr. Duffin, and is inserted in this communication. I shall also endeavour to state clearly some of the important points of difference between us.

It is not a little curious, that upon this question of observation, Kölliker, Kühne, and myself, should all have arrived, not only at different, but at incompatible results. At the same time it must be admitted that the enquiry is a most difficult one, and the delicacy of the structures renders the utmost skill and care necessary, in the preparation of the specimens, while in consequence of the extreme fineness of the nerve fibres, the highest magnifying powers are requisite.

In 1859 I noticed that the elementary muscular fibres of the mouse were crossed at short intervals by pale granular nucleated fibres, which could be traced for a long way amongst the muscular fibres. I knew that some of these must be capillaries, but there were others which ran for a longer distance without dividing, and were paler and less distinct than the vessels, and which branched in a different manner, and were evidently nerves. I therefore determined to work at this subject, and studied especially the diaphragm, tongue, and other muscles of the white mouse. The capillaries were injected with Prussian blue, and so all chance of mistaking capillaries for nerves—an error very easily committed in uninjected preparations—was avoided. In my paper I endeavoured to prove:—1. That the dark-bordered fibres were much more numerous than would be inferred from the descriptions generally given, and ramified freely in every part of the muscle.—2. That pale

flattened fibres which contained numerous oval nuclei, crossed the fibre at short intervals in every part.—3. That these pale fibres were continuous with the dark-bordered nerve fibres.—4. That these fibres and their nuclei had been included in, or considered as "connective tissue."—5. It was shown that these pale nucleated nerve fibres were much more numerous in some muscles than in others of the same animal, and in the muscles of birds and mammalia, than in those of reptiles and fishes. —6. That the pale nucleated fibres formed networks outside the sarcolemma arranged after the same fashion as those formed by the dark-bordered nerve fibres as seen by low powers.—7. The fine pale fibres could be seen at the edge of the muscular fibres, and with the vessels could be stripped off from the sarcolemma. They often crossed the fibres at right angles, so that one fibre might influence a great many elementary fibres. These conclusions, with observations upon the tubular membrane, axis cylinder, and white substance of nerve fibres, and on the so-called connective tissue, were embodied in a paper read before the Royal Society in June, 1860, and printed in the "Phil. Trans."

Early in the present year (1862) Dr. Kühne, of Berlin, published an elaborate memoir "Über die peripherischen Endorgane der motorischen nerven." In this paper, the author supports his previous observations upon the termination of nerves in the muscles of insects. He came to the conclusion that the nerve, or rather its axis cylinder, passed through the sarcolemma, and came into contact with the contractile tissue within, being probably connected with rows of nuclei (muscles of the leg of hydrophilus piceus). The thin breast muscle of the frog was specially examined, and the conclusion was arrived at, that at one point of the muscular fibre the axis cylinder passed through the sarcolemma, and divided into two or more branches which contained peculiar oval bodies (nervenend-knospen). After passing a short distance beneath the sarcolemma, these pale fibres terminated in the peculiar oval bodies or in pointed extremities. The oval bodies exhibited a peculiar structure, and were regarded as special organs.

If my drawings, published in the Phil. Trans. 1860, be referred to, it will be noticed that the pale fibres seen by me in the muscles of the mouse, were followed much farther, amongst the fibres upon their external surface, than Kühne had been able to trace the pale fibres beneath the sarcolemma in the frog. The vessels in his specimens were not injected, and the preparations were examined in fluids containing much water. He refers to my observations, but had not seen my drawings,

or the original memoir. Had Kühne had this opportunity, I feel sure that he would not have suggested the possibility of the nerves I had figured being merely vascular nerves, nor would he, I think, have so cursorily referred to my conclusions as he has. It is obvious that this and kindred enquiries, cannot be forwarded by one author remarking of the observations of another, that doubtless the fibres described belong to the connective tissue, and so forth. It is in this indefinite "Bindegewebe" that many structures have long lain buried; and, there can be no doubt whatever, that in very many instances some of the "bindegewebskörperchen" are connected with nerve fibres, and other structures which had been rendered indefinite and fibrous in their appearance by the action of water. For example, several of the nuclei represented in Kühne's Fig. xv, are, I believe, the nuclei of true nerve fibres, and do not belong, as he states, to the connective tissue.

Within a month after the appearance of Kühne's paper Professor Kölliker published in his "Zeitschrift," some observations upon the termination of the nerves in the muscles of the frog. Soon after Kölliker's statements against Kühne's observations appeared, Kühne published the following short paper in "Virchow's Archives," vol. xxiv. :—

"PRELIMINARY REMARKS UPON A PRELIMINARY COMMUNICATION OF MR. A. KÖLLIKER'S, BY DR. W. KÜHNE."

"Mr. A. Kölliker, of Würzburg, almost directly after the publication of my pamphlet "On the Peripheral Terminal Organs of the Motor Nerves"* promised that he would soon overthrow all the facts therein contained.† However little the success of this undertaking might flatter me, I should most heartily admit the eminent talent of Mr Kölliker, had he actually been able, in such an extremely short time, to discover the method of termination, not only of all motor nerves in voluntary muscle, but also the peripheral relations of all nervous structures in every muscular organ. Be it observed that Mr. Kölliker has in the same short period carried his researches so far as to promise that he will show us in a more extended work, with many engravings: A, the ends of the motor nerves in voluntary muscle; B, those of the sensitive

* Über die peripherischen Endorgane der motorischen Nerven. Von Dr. W. Kühne. Leipzig, bei W. Engelmann, 20th Feb. 1862.

† Über die letzten Endigungen der Nerven in den Muskeln des Frosches. Eine vorläufige Mittheilung, von A. Kölliker, vorgetragen am 8 und 22 März., 1862. Würzburger naturwissenschaftliche Zeitschrift, B. III.

nerves in the same situation; C, those of the vascular nerves; E, the ending of the nerves in the heart; F, the ends of the nerves in unstriped muscle; and he announces under D, peculiar Köllikerian nerve swellings (Nervenknospen)."

"I would not for a moment in any way impede Mr. Kölliker in the fulfilment of his friendly promises by my remarks, nor can I be desirous, by a reply—for this would be a bad service to my own cause—to touch upon matters which might disturb or even delay the designs of Mr. Kölliker. My observations shall in part contribute to expedite the appearance of the promised work with the many engravings, and in part they shall direct attention to some points which Mr. Kölliker appears to have forgotten to touch upon."

"1. Mr. Kölliker has omitted to say decidedly what novelty he has discovered. He dilates upon the psychical effects, which, according to him, the nerve intumescences that I have described produce. He also finds time to relate what he has not seen, for he objects to me that I have endowed the structure of the nerve intumescences with wonderful peculiarities; and then he assures us that the ramifications of the nerves always lie on the sarcolemma, and that a nerve never penetrates the muscular fibre. I conclude from this that Mr. Kölliker has never yet seen a terminal nerve intumescence, and consequently that he had not the slightest occasion to declare that these were 'nothing but nuclei—true ordinary cell nuclei.' May Mr. Kölliker then teach us to recognise the cells which belong to these true ordinary cell nuclei!"

"2. Mr. Kölliker has described something as new, which another observer had previously published as a discovery, and this, too, with many engravings. Mr. Kölliker says that the nerves between the muscular fibres first lose their white substance, and that these nerves, which only still consist of neurilemma, nuclei and axis cylinder, branch, and that the ultimate still nucleated processes of these branchings no longer admit of any distinction between sheath and axis cylinder. If this is a new and positive matter which Mr. Kölliker considers himself entitled to make use of in the fulfilment of his promise, I cannot help expressing my surprise that this very Mr. Kölliker, who annually returns to us from England in the freshly burnished splendour of his name, should have overlooked the researches of Dr. Lionel Beale, which have been already two years printed in the 'Philosophical Transactions.'"

"So far as the observations with which Dr. Beale has just been enriched in the communication of Kölliker, I may rejoice that I have not obtained his adhesion, and can only hope that

he will soon give me an opportunity to prove in detail the harmony of his assertions with those of Beale, whose deficiencies I have moreover briefly indicated in my pamphlet."

I cannot help expressing regret that Kühne should have referred to Professor Kölliker's work in this manner, and although the distinguished Berlin physiologist might reasonably have expressed surprise at the very rapid manner in which Professor Kölliker has carried out his new investigations, he can hardly suppose that sharp writing will assist us in the investigation of difficult anatomical questions. For myself I can only say that I shall be quite ready to acknowledge the truth of Kühne's view, or that of any other observer, if I can obtain or be shown specimens confirmatory of his observations; but as I have spent considerable time in the investigation of this anatomical question, I cannot submit to the unceremonious dismissal which this authority has accorded to me in the last paragraph above given. He seems to think that the few observations he has made upon my paper (pp. 28, 29) are sufficient to upset my conclusions. I do, however, trust that Dr. Kühne, before he again proceeds to indicate my "deficiencies," will just read my observations, or, at the least, obtain a sight of my drawings. I cannot but think that my friend has been altogether a little severe, while many of the appearances he has represented in his own drawings are certainly open to severe criticism.

Kölliker has given the results of his investigations in his Croonian lecture to the Royal Society, in May, 1862, published in the proceedings (vol. xii, No. 50), and more fully in the fourth edition of his "Handbook." He states that he was not able to discover the "nervenendknospen" described by Kühne. He agrees with me that the nerves are situated outside the sarcolemma, but maintains, with Kühne, that they terminate in free extremities. Kölliker admits that I have proved the existence of pale nucleated fibres, but not their arrangement in the form of a network. He should, however, bear in mind that at least these fibres have been positively traced much farther from the dark-bordered fibres than his ends are situated. In a note* appended to his Croonian lecture he gives the following extract from my paper, with his remarks thereupon :—

"The axis cylinder gradually loses its hard fibrous character (frog) and the white substance, its peculiar refractive power

* The lecture itself is in the main an attempt to refute the special conclusions of Kühne, and the general views entertained by other observers were not referred to.

and consistence. The whole fibre, as seen in my specimens, seems to consist of a very transparent, and perhaps delicate, granular substance, which can be shown to be composed of fatty and albuminous materials, &c."* "Judging, however, from Dr. Beale's figures, which represent the terminal network of the nerves distributed on the muscular fibres of the mouse, and from his description, I am led to conceive, that he has not observed what *Kühne and I* have seen." All that I meant to express was, that the *general arrangement* in the frog and other animals was the same as in the mouse which I examined specially. In the mouse, the pale fibres are broader, and their nuclei far more numerous than in the frog, and they cross the fibres at very short intervals. I have shown the very extensive course of the pale fibres, their varying number in different muscles, and the more abundant presence of nuclei in the nerves of some muscles than in those of others. With regard to the network I have described, it must not be supposed that I consider that the nerve fibres anastomose like capillaries, but that the fibres of the network are compound, so that different sides of a mesh may be formed of different fibres, as represented in Figs. 7, 8, 11, 14, 15, of my paper. Kölliker is quite right in his supposition, that I had not seen the peculiar fibres delineated by Kühne and afterwards by himself, on the fibres of the breast muscle of the frog; but I had seen enough in other muscles of the same animal, to make me conclude that the elementary fibre is supplied with nerves, not in one spot only, but at several points along its entire length, and I had followed the pale nucleated fibres in very many instances, for a far greater distance amongst the muscular fibres, than the point at which he and Kühne make them *end*, in their memoirs published two years after my own.

As Kühne and Kölliker had investigated the arrangement of the nerves in the breast muscle of the frog, and had arrived at conclusions which were quite incompatible with my observations, and were in harmony with their respective views expressed some years before, I thought it desirable at once to study the same muscle, with reference to this much debated question. My memoir, accompanied with numerous drawings, was read before the Royal Society on June 19 of the present year, and will be published in the next volume of the Phil. Trans. The summary will be found in the same number of the "Proceedings" as that in which Kölliker's lecture is published. These observations are opposed to those of Kühne and Kölliker.

* From my paper, Phil. Trans., 1860.

The finest fibres are nucleated, but as I have stated, are much finer than those delineated in the muscles of the mouse, and they are much more sparingly distributed to the muscular fibres, but their general arrangement is the same. They lie external to the sarcolemma, and the divisions after crossing numerous muscular fibres at different angles, and dividing and subdividing, form, with other fine branches, networks, often with very wide meshes.

From my most recent investigations upon the distribution of nerves to the muscles of the frog, I have been led to the following conclusions:—

1. Pale nerve fibres which contain nuclei, and are the direct continuation of dark-bordered fibres, have been followed amongst the muscular fibres for distances, from a dark-bordered fibre of the same diameter as those figured in the drawings of Kölliker and Kühne, more than ten times as great as the point where they make the pale fibres end.

2. If, therefore, the nerves terminate in special bodies beneath the sarcolemma, the terminal fibres must be far finer than Kühne represents, and their terminations must be very much farther from the dark-bordered fibres. The fine nerve fibres I have seen are less than one-fifth of the width of Kühne's pale fibres beneath the sarcolemma.

3. And if they terminate in ends, as Kölliker maintains, external to the sarcolemma, these ends must be situated at a much greater distance from the dark-bordered fibre than he supposes.

4. But these fine nucleated fibres really pass on as distinct but very delicate and scarcely visible nerve fibres, often close to the capillary vessels; and they form, with other branches, a network with very wide meshes. The fibres themselves, as in other cases, really consisting of two or more. The fibres have, therefore, a very much more extensive distribution than Kühne and Kölliker admit.

5. The fibres described by Kölliker as the *sensitive fibres* of the muscle may in every instance be followed for a very long distance (for example, transversely over twelve or more large muscular fibres), and do not terminate as represented in his drawing.* They can, in all instances, be traced to the connective tissue upon and between the muscular fibres, and are connected with many of the so-called connective-tissue corpuscles. These fibres are much more numerous and more readily followed in the adult than in the young frog. It seemed

* Proceedings Royal Society, No. 50, p. 76, Fig. 3.

to me probable that these fibres are the very fibres which were distributed to muscular fibres of the muscle at an earlier period of life, and it is possible that they may still serve with the other set of fibres to complete nervous circuits. The bundle of dark-bordered fibres, distributed to the breast muscle of the frog, is composed of both sets of nerve fibres (motor and sensitive, according to Kölliker)—all can be followed for a considerable distance, and would be said by some observers to lose themselves in connective tissue. But the first set of dark-bordered fibres divide into branches which pass at once, and by a very direct course, to the muscular fibres, becoming very thin, pale fibres rather abruptly, while the second set (Kölliker's sensitive fibres), on the other hand, pursue a very long course, gradually becoming thinner and thinner, until they are distinguished with the utmost difficulty from the connective tissue on the surface of the muscle and between the elementary fibres.

6. My observations lead me to think, that some of the nuclei delineated by Kühne, in connection with the nerve fibres beneath the sarcolemma, are really only nuclei (masses of germinal matter) of the muscular tissue altered by preparation; and I am strongly of opinion, that the rows of nuclei, represented in Plate ii, Figs. 9 and 10, from hydrophilus piceus, extending throughout the length of the muscular fibre, are the "nuclei of the muscle," and so far from being connected with the nerve are embedded in the central part of the contractile substance, as shown in transverse sections of the fibres.* They extend from one end of the fibre to the other. What Kühne describes as an axis-cylinder in these figures is, I think, probably a nerve; and what he terms the nucleus of the nerve sheath, the nucleus of nerve itself. In fact, the fibre which he regards as the nerve fibre, is, I believe, a bundle of many fine nerve-fibres with numerous tracheæ. This bundle, instead of passing through the sarcolemma, remains upon its surface, subdivides into numerous branches, some of which cross over and pass to other muscular fibres, while others become so attenuated and transparent, that they cannot be followed.

I much regret that our conclusions should be so different and so incompatible. I shall endeavour to prove, that the nerve fibres which are represented in my former paper cannot

* See also the description of these nuclei in Dr. Duffin's abstract of Kühne's researches on page 143. The arrangement of the nuclei is well described, but the assertion that "the rows of granules in the muscles of insects are but the extension of the true intramuscular axis-cylinder of the motor nerve-fibres," is one which it seems to me cannot possibly be accepted upon the very unsatisfactory evidence brought forward in its favour.

possibly be vascular nerve fibres, as my friend supposes. In Figs. 5 and 9, of my paper of 1860, vascular nerves are delineated as well as the motor nerves. I trust that Kühne will re-examine the muscles of the hydrophilus and other insects, as I feel sure, he will find an arrangement of the nerve fibres upon the surface of the sarcolemma, much more elaborate than that which he represents. This is alluded to in a note to my paper. The great difference between us however is, with regard to the question of *ends* to the nerves; Kühne and Kölliker both agree as to the presence of ends. My conclusions are opposed to the existence of ends at all. But if the nerves do terminate in ends, they are most certainly situated at a much greater distance from the dark-bordered fibres than those observers suppose.

The important part of the peripheral nervous system in tissues and organs generally, only commences at the point where the dark-bordered fibre seems to cease, and it is far more extensive than is supposed in Germany, extending amongst the tissues in the form of a most elaborate compound network or plexus. The nerves never lose themselves in another tissue, or become continuous with it. They are brought into another close relation with other tissues by their nuclei, but they never lose their distinctness as a special nervous tissue, which is developed and grows in a manner distinct from the tissues, in which it ramifies. Some of the finest peripheral branches of nerve fibres, in the mucous membrane of the epiglottis of man and in the bladder of the frog, are represented in Plates XV, XVI, XVII, XVIII.

CLINICAL OBSERVATIONS,

ON OPHTHALMIA.

By Jeffery A. Marston, M.D., Assistant-Surgeon, Royal Artillery.

(*Supplement to former Paper—page* 220.)

Learning that ophthalmia was prevailing in an epidemic form at the Central London District Schools, I applied for permission to inspect the affected children. Through the great courtesy and kindness of the medical officers I was permitted to do so.

It was with much interest that I witnessed for the first time in England an ophthalmia, prevailing in an epidemic form, under circumstances perfectly parallel with what is found in military life, and with symptoms so essentially similar to those I described in my last paper, as to leave no doubt of its identity with the military form.

I gather the following facts from the published report of the Committee, appointed in September, 1861, to inquire into the state of health of the children of the school:—

The Central London District comprises—

City of London Union,
East London Union,
West London Union,
St. Saviour's Union, Southwark,
St. Martin's-in-the-Fields Parish.

The then present number of children was 1,148.

The Committee was assisted in their inquiries by Mr. H. Haynes Walton.

The physical characters of the children at the different London Institutions were alike, inasmuch as they were gathered from a very low class, from crowded habitations, and presented the same general features, physically and morally, on their admission into the different schools.

It would appear that the health of the children at the Central London contrasted with that of the schools of other districts, principally, though by no means entirely, in the prevalence of ophthalmia. This disease had prevailed at the date of a similar commission in 1858.

The Committee advert to the disproportionate number of children at the Central London School affected with itch, and other cutaneous diseases, compared with other schools.

They remark upon the defective (excessive) ventilation and heating at the Central London Schools, and quote Mr. Haynes Walton to the effect that the disease was catarrhal ophthalmia, and not depending upon contagion or infection, nor excited by the mechanical irritation of dust, but that the *existing* cause of the disease was excessive ventilation.

Mr. Bowman, in 1858, had pointed out that the fresh air was admitted into the dormitories, directly from without, through a grating in the wall near the head of the beds. The corridors at Hanwell run the whole length of the building, from east to west, giving rise to strong currents of air. No distinct building existed as an infirmary. Under the head "*bathing*," the Committee remarked that the troughs in the boys' washing room were in an unclean condition. At Sutton School the Committee state that each child had a separate towel, which was not the case at the Central District Schools. (One towel to ten was the average.) At the Forest Gate School every child had fresh water for ordinary washing, and large plunge baths were supplied also with water constantly running in and out. No large day-rooms appeared to be set apart for the children during inclement weather, as at three of the other schools.

The Committee after regretting the existing state of bad health among the children of their school, as compared with the others, express their opinion that, "had the recommendations contained in Mr. Bowman's report in 1858 been rigorously enforced, much, if not all, the ophthalmic disease would have disappeared, certainly would have been much diminished in extent and danger."

Mr. Haynes Walton in his report October 1st, 1861, denominates the disease "catarrhal ophthalmia," existing in the mild and definite form, and not having passed into the purulent Egyptian, or military ophthalmia; that it was uncomplicated, that it was caused by atmospheric influences; that, though it prevails every year, it is occasionally epidemic, and had been very prevalent that year in London. Respecting its contagious or infectious nature he says "I am not aware that the matter conveyed from the eye of one person to another will produce it, such evidence as I can gather is against it; of its infectiousness I have no faith, and therefore I think that no advantage is to be got from isolation."

He appeared to consider the ventilation as the existing cause, and that the washing department was efficient, although he recommended, to be upon the safe side, that no one who had the disease should be allowed to wash with any healthy person, until he was quite well.

Mr. Walton did not consider that the prevalence of dust from the yard, had the least influence in causing the disease, as he says "irritation of the eye, arising from the intrusion of extraneous bodies, however minutely subdivided, is attended with very different symptoms."

Mr. Bowman in his report, in June 1858, appears to have recognised and spoken of the occasional epidemic character of the disease, and its spread by contagious influences, and to have pointed out the indications such a view would entail.

Owing to the continuance of ophthalmia, Mr. Bowman revisited the school upon 21st and 27th March, 1862.

Whatever might have been the disease hitherto, it was then no longer a simple malady, as regards its extent or consequences.

From Mr. Bowman's report of the latter date I gather, that ophthalmia was extensively prevalent, affecting about 686 of 1,162 children; 92 cases were separated and about 594 remained unseparated. Of these about 396 were cases relapsing after apparent cure, and 193 were slight commencing cases, not yet brought under treatment.

Mr. Bowman, writing for the perusal of non-professional men, says, "The Ophthalmia presents itself under four conditions, which I will enumerate as A, B, C, and D.

"*Condition A.*—Slight redness of inner corner of eyes. The inside of lids red. The eyes itch, look weak, and are often rubbed with the fingers. This, which is the common early stage, may vary in intensity, and may last for some time without attracting attention. To be detected early *it must be looked for*.

"It differs from ordinary catarrhal ophthalmia, on which I reported to you in 1858, by its persistency, and by its not tending to a speedy natural cure; by its liability to pass into the next condition (B), and also, as might be hence inferred, it differs in my opinion most essentially in its *cause*. I believe it to be propagated from one affected person to another.

"*Condition B.*—Worse stage of condition A. The eyes would be called *badly inflamed*, the edges and corners of the lids are more red, somewhat swollen and wetted with a good deal of discharge. There is itching, smarting, and intolerance of light. The inside of lids is of a lake colour, the membrane thickened and rough with small granulations. It is the same as condition A, but *with more inflammation*.

"*Condition C.*—is the most terrible form. The inflammation is so intense as to swell the lids rapidly with much pain and profuse suppuration"—purulent ophthalmia in short. "This

severe variety presented itself in January, and has occurred only among the younger boys. There have been about 30 cases in all, and of these 7 eyes appear to have been lost.

" *Condition D.*—This I particularly specify in the present report, because of its importance in reference to the arrest of the disease, and its eradication from the school. It is the *convalescent* and at the same time the *relapsing condition,* in which an apparent cure having been effected, the treatment ceases, and the child is sent back among his fellows, until the symptoms again become urgent enough to call for his re-separation. I was informed by your medical officers that since June the children have been in many instances sent back from the ophthalmic ward into school, apparently cured, and then have had to be separated again within a few days, in consequence of a fresh attack.

" 'Frequently in going round the school,' says Mr. Goodchild, 'we have seen cases among those who had been apparently cured, and who had consequently been allowed to return into school, and we have had to isolate them again. We have also at the same time seen *other new cases,* which had to be sent into the ophthalmic ward. Relapses have been frequent.'

" In this condition (D) of *convalesence* or *apparent cure*, but where relapses are so apt to occur if treatment is intermitted, the eyes have *nearly* lost their redness, but it quickly returns on slight excitement. There is very little discharge, but a little increase of redness is followed by a more abundant secretion, and the inner surface of the lid is found to be still too thick, and more or less granulated.

" By the mere intermission of treatment the discharge accumulates, the eyes get dirty, and the disease relapses.

" Of the 594 children whom I estimated as having ophthalmia, yet as mingling with the healthy children and not under any special treatment, a part were under condition A, and a part were under condition D, *i.e.*, they were either slight commencing cases, or nearly cured, or relapsing cases, in about the proportions already specified."

Numerous recommendations then follow upon the view, which he most strongly urges, of its infectious or contagious nature. " Under circumstances not easy to explain or to specify, but usually connected with over-crowding and want of cleanliness, the milder forms may pass with more or less suddenness into the more severe. In the present instance all the children seized with the more virulent form were already suffering from the less virulent, and several had been long under treatment. It would appear that in January and February the

type of the disease changed in many instances; or else that a *single severe case having occurred in the boys' ophthalmic ward, others were contaminated by it,* for *the severest purulent cases were* not *at first isolated from the less severe ones.*

"It is noticeable that *all* the *worst* cases (form C) have been among the *boys,* none among the *girls,* although at the period of my visit girls were affected in greater number."

Extract from Mr. Bowman's Report, April 11th.

"For the single object of eradicating the ophthalmia a removal of the children who are now *healthy* for a time to some other suburban locality, or even to their own several workhouses, would seem to be a wise course, if only on their own account, and it would enable the officers to spread the suffering ones over a much wider area, afford them better ventilation, and give them a bed each."

Prevalence of the disease.—I made my first visit towards the latter end of April, and, examining individual children taken at random from those outwardly healthy, it was the exception to meet with a perfectly healthy condition of the conjunctiva.

Abstract from Three of Mr. Bowman's Weekly Reports.

Date.	Class A.	B.	C.	D.	Total cases.	Total children in School.
April 19	277 ..	88 ..	26 ..	59 ..	450	1,132
May 21	320 ..	65 ..	7 ..	92 ..	482	1,040
June 21	273 ..	34 ..	11 ..	98 ..	416	992

Its origin.—This is doubtful, but it may be remarked that Mr. Goodchild noticed that after the introduction from St. Pancras in 1858 of some children, affected with ophthalmia, the disease became more frequent and troublesome at the Central District Schools. Whether it took its origin from this source, or whether ordinary catarrhal ophthalmia, when protracted and widely prevalent among human beings living together under a defective hygiene, can assume the specific characters described, cannot be accurately determined. My own impression is so strong as to amount to a conviction that either of these conditions is adequate.

Its nature.—That form of ophthalmia which prevails in armies, and other bodies of human beings similarly circumstanced, and, whatever be its exact pathology, possessing the

characters I have already described. The earliest and perfectly latent stages were comparatively absent, owing to the widely spread operation of exciting causes, and the epidemic influence. There were, however, large numbers of children affected with the sparsely shed "vesicular" or "sago grain" bodies, in different stages, as regards vascularity, limited to the retrotarsal fold of conjunctiva at the outer canthi, and offering no symptoms indicative of their presence, without a careful scrutiny of the lids. Entering the school-rooms, no one would have imagined from the appearance of the children the widely spread prevalence of the disease, such an absence was there of any appearance about the children's features, or the exposed surface of the conjuctiva to indicate it.

Mr. Bowman, recognising the presence of these "sago grain" granules, in many of the cases, holds strongly to the opinion, from their definite seat and character, that they must have their origin in a distinct physiological structure.

The causes.—Those of constitution, as congenital or acquired debility of constitution, such as must widely prevail among the children of the poorer population. That these are insufficient to account for all the cases, or the spread of the disease, will be apparent from the fact, that children of every constitution, physique, &c., have suffered in different degrees, just as was observed among the military, and in the Gibraltar convict establishment, where the disease attacked individuals of every type and conformation of body.

Contagion.—Into this I need not enter further than to remark that such an agency is generally allowed, and that Dr. Piringer, Van Roosbröeck, and others, have produced ophthalmia by inoculation of purulent discharges obtained from various sources. The latter, indeed, goes so far as to classify the Egyptian, military, and gonorrhœal forms under the same head, declaring that the diseases resulting from pus-inoculation are essentially the same, the different degrees of intensity resulting from the different sources (*quoad* intensity of inflammation), from which such discharge has been produced and obtained. The experience obtained from cases of artificial conjunctivitis by pus-inoculation is highly corroborative of the truth of Van Roosbröeck's statement, inasmuch as it has been found that the more intense the inflammation producing the pus used, the more intense the inflammation resulting from its use. Assuming that the disease *only* spreads in the *direct* way (which has not been yet proved), and that the contact of discharge from a diseased eye is essential to its production, it is still impossible to say in what stage *no* discharge whatever is

present, for in the earliest, a little blinking in the sun, and slight gumming of the lids can be made out upon close enquiry; while in others, further advanced, we may often discover threads of muco-pus by eversion of the lids, although the symptoms appear very trivial. Granting the disease to be contagious, we have, it appears to me, not far to go to seek the causes for its epidemic prevalence at the school in question.

We have seen from Mr. Bowman's report that affected children had been allowed to mingle with the healthy. Fresh towels had been supplied daily, in the proportion of one to ten children. The children washed in wooden troughs (not a running stream)—by relays.

The bath is capable of holding about twenty; the dirty surface water drains off by one opening and fresh water flows in by another, so that the water is replenished without being *thoroughly renewed.* Up to the date that Mr. Bowman undertook the investigation into the causes of the epidemic, it does not appear that any means for the prevention of the spread of the disease were vigorously pursued. The first efforts were directed to the discovery, classification, and isolation of all cases of the disease, however slight.

Very many of the children slept two in a bed, and they occupied the same rooms by day, during wet weather, as at night.

The school rooms were divided by curtains (retentive of dust) for the purpose of facilitating class teaching.

The rest may be summed up in the expression, that the children are subject to those evils to which persons living in a gregarious manner must, in different degrees, be always exposed.

Of the *exciting* causes we have two of a well defined character present, and to which I have particularly alluded in my preceding paper, viz.:—1. *Catarrhal Causes,* as pointed out by Mr. Bowman and Mr. Haynes Walton.

2. *Dust.*—A large quadrangular yard exists, covered with an impalpable dust, particles of which penetrate everywhere. That such dust, *per se,* gives rise to a different and easily distinguished disease is true enough, but this is not by any means the case where other and more widely prevailing causes are present; then it takes its place as an irritant. Among the exciting causes Mr. Bowman speedily recognised the presence of dust as one urgently requiring removal.

RESULTS OF SOME ADDITIONAL OBSERVATIONS.

I. The reaction of the conjunctival secretion was tested in a great many instances. With one exception, the re-action

was always weakly alkaline. The effect upon test paper was permanent also, indicating the presence of a fixed alkali. The lotions used were perfectly neutral to the same test paper.

II. With the view of corroborating the statement that pus was present in the air of ophthalmic wards, the bodies floating in the atmosphere of the wards were collected and examined, with negative results however, as regards pus cells. Dissatisfied with the very limited observations made in the wards, I have since used the aeroscope in a room, wherein some fluid pus was exposed. The bodies collected were examined microscopically. Beside dust, fibre, cotton, &c., there were organic bodies of various kinds and forms, (in very great part vegetable germs far smaller than pus cells).

Numerous minute germs (often as small as $\frac{1}{10000}$th inch in diameter) were found. That these were in great part vegetable, I think conclusive from the fact that sporules of fungus, and cellular bodies arranged in a linear series forming filaments, or mycelium, subsequently appeared upon the slides.

I found that if portions of cotton, wool, or lint, soaked with pus, be first desiccated, and the current of air passing over these be received by the aeroscope, some pus cells can be discovered with detached and isolated fibres of cotton; but no pus cells were found so long as the lint remained moist.

III. The worst cases and those in which the cornea sloughed or ulcerated, and sight was more or less destroyed were either compound in nature, the contagious ophthalmia engrafted upon the strumous form, or the purulent form of the disease in children of very delicate conformation of body and deficient powers of circulation.

As far as these unfortunate children were concerned they had all the advantages derivable from subsequent operative interference at the Moorfield's Ophthalmic Hospital, and with very gratifying results.

The sago-grain state of lid, advanced to the vascular or congestive stage, formed by far the larger proportion of the whole number affected.

Subsidence of the vascular phenomena was easily procured by mild treatment. Depletion and all lowering remedies were quite out of the question, owing to the tender age and defective nutrition of the patients.

IV. Mr. Bowman holds (of the truth of which I have no doubt) that it is well to *watch*, but not interfere with the quiescent stage, as astringent applications would probably only *induce* vascular phenomena.

In conclusion, I must thank Mr. Bowman for his kindness in giving me the benefit of the perusal of his reports. I may remark (with all modesty be it said) that I could not expect any thing in these papers to be new to a man of Mr. Bowman's observation and experience. He has most minutely pointed out the causes of its epidemic prevalence, and, by a series of most lucidly written recommendations, he has endeavoured to grapple with the disorder with a large measure of success. But the subsidence of such a disease must necessarily be gradual, not only on account of its obstinate nature, but because the necessary sanitary measures cannot always be carried out as efficiently and as early as would be desirable, owing to the conditions incident to a large pauper establishment. The Board of Management have shown the most praiseworthy desire to improve the hygienic state of the buildings by taking the steps recommended, regardless of cost. It may be hoped that a repetition of such an epidemic in future will be thus in a great degree guarded against.

Conceiving that it would be adding to the practical character of this paper, I have appended a series of sanitary suggestions.

Practical Recommendations to be put in force in a Regiment afflicted with Ophthalmia.

1. That all the men of an affected regiment be inspected by a medical officer at least once daily, with the view of removing at any rate all cases affording any discharge from the eyes.*

2. To make the men, as far as practicable, wash at a pump, having placed a sentry upon the spot with orders to see that every man brings his towel with him.

3. To place a sentry upon the lavatory to see that every man brings and removes his own towel, fills a basin with water from the tap, empties the same after washing, and refills the basin for his successor, who shall empty the water so left and refill the basin before using it.

4. To institute (if season permit) frequent bathing parades—four times weekly. It is better to make the men bathe in the evening in warm climates, both because it sends them to bed perfectly clean and refreshed after the duties of the day, and,

* If a man affected with ophthalmia joins a regiment, it is better to billet him upon a company in which ophthalmia has been present than upon a company free from granular disease.

by encroaching upon their spare time, prevents it being spent in public houses, &c.

5. To avoid, as far as possible, the exposure of the men to the direct rays of the sun, dusty localities for parades, and the massing men together on parade.

6. Frequent exercise in the air in small parties of four to six men, whether affected or not with the disease,—provided that direct sunshine and easterly winds be avoided.

7. To have separate wards for ophthalmic cases, and it is recommended that the worst (purulent) cases be separated from the less acute and less advanced forms of the disorder.

8. Convalescent wards in hospitals, and convalescent rooms in the barracks, for men who have been treated, so that every affected case can be made to pass through a period of probation and observation before joining his regiment in the ordinary way. By this means the danger of contagion from relapsing cases will be avoided.

9. If the men of one room be affected, it is obviously well to clear out that room for a time, and to whitewash it.

10. To see that all bedding, &c., be daily exposed for some hours to the sun and air, and the barrack-rooms thoroughly ventilated. To ensure this being done efficiently day-rooms for the men are essential.

11. To increase as much as possible the cubic space for the inmates of the barracks.

12. The strictest attention to the latrines, urinals, &c.; closing those which are placed too near the barrack-rooms; directing that the tubs be placed outside the rooms during the night, and filled with water and some disinfectant during the day.

13. To discover, correct, and remove any such exciting causes as may be prevalent—*e.g.*, draughts in the rooms; dust in the barrack yards, and by selecting a cool part of the day and the shade for all necessary parades.

14. Cautioning men against the indiscriminate use of pocket handkerchiefs, &c.

15. The use of tow, cotton wool, or lint in hospital—the destruction of the same after use, with a strict prohibition against all sponges.

16. If the barracks be badly constructed, low in site, or otherwise defective, obviously a change is necessary, and encamping is far preferable, during even hot weather, to inhabiting such buildings. Splitting up the regiment into small bodies is to be strongly recommended also.

17. It is recommended when one eye only is affected, and affording discharge, that it be kept closed by means of

cotton wool, to prevent the discharge coming into contact with the sound organ, which is apt to occur during the night from the patient's fingers. The only objection to this plan is, that it tends to heat the eye and confine the discharge; this can only be guarded against by frequent inspection and syringing.

18. To ensure a prompt and efficient execution of any sanitary measures, it is necessary to obtain from the commanding officer one or more steady and vigilant non-commissioned officers with some soldiers to act as sanitary police. Great care should be exercised also in obtaining trustworthy, cleanly and attentive nurses for the sick, particularly in the purulent ophthalmic wards.

CASE OF DIABETES INSIPIDUS, OR HYDRURIA, ACCOMPANIED WITH ENTIRE ABSENCE OF THE PARENCHYMA OF BOTH KIDNEYS, WITH REMARKS ON THE DISEASE.

By William Strange, M.D., Physician to the Worcester General Infirmary, &c.

I was about to prepare the following very unusual and instructive case for publication, when I met with Dr. Eade's cases and valuable remarks in the January number of the "Archives." The case which I am about to relate differs very essentially from all those which he has narrated, and I am not aware of any recorded instance of great and long persistent diuresis in which post mortem examination revealed a similar condition of the urinary apparatus.

Case.—John Nash, æt. 18, a farm labourer, was admitted into the Worcester Infirmary, under my charge, October 19, 1861. He had been an out-patient a week or two previously, but, on hearing his case, and receiving a specimen of the urine, I persuaded his mother to send him into the house. On admission he presented the appearance of a moderately stout lad of 15; being of small size, especially as to his hands and limbs; face ruddy; skin and tongue natural; lungs healthy; heart's action regular, but impulse rather weak; no bruit with either sound; pulse rather quick. His appetite was stated to be normal, but his thirst was, and had been during the whole term of the complaint, excessive; so that he was in the habit of rising more than once in the night to drink large draughts of water. The bowels were generally relaxed; there was no œdema of any part of the body, and the skin, although not perspiring, did

not present the shrivelled and harsh condition which is generally characteristic of diuresis of all kinds. On examination of the urine it was found to amount to about twelve pints in the twenty-four hours; and this, he states, had been about the quantity for years. Sp. gr. 1007; no albumen, and, of course, no sugar; Moore's and Trommer's tests having both been applied. Some mucous particles subsided on standing, and ether removed a small quantity of oily matter; chlorides normal. The microscope revealed no casts of tubes, nor other structure. All the history I was able to obtain was that he had always been a delicate and backward boy; that he had had this diuresis for a number of years; and that the medical attendant had always affirmed that it did not contain sugar.

Treatment and progress of the case.—Being desirous of seeing whether the diuresis was kept up by the excessive imbibition of fluids, in accordance with the theory of my friend Professor Bennett and others, he was restricted to a more moderate allowance of fluid, chiefly by taking away his accustomed drink in the night, farinaceous diet, and one pint of beer. He took dilute phosphoric acid with Tr. of nux vomica in infusion of quassia, and had a warm bath twice a week. On the 23rd, four days after admission, the urine was nine pints, sp. gr. 1006.—26th. Bowels much relaxed, urine five pints.—28th. Omit phosphoric acid mixture, and let him take mist. cretæ co.; complains of headache for the first time, with weakness and loss of appetite, some febrile symptoms.—29th. Bowels being still relaxed, add 5 minims Tinct. opii and ʒss, Tr. catechu to mixture.—30th. Became drowsy, with pain at the back of the head; diarrhœa continues, with vomiting of mucus. To have an effervescing mixture with ʒss doses of Sp. ether. nit., omit the rest. To have half an ounce of brandy in water three times a day, and cold to the head.—Nov. 2. Drowsiness and sickness abated, bowels confined, urine three and a half pints, Sp. gr. 1004. To have ol. ricinæ ℥ss, and the brandy to be omitted. It now appearing that mischief had resulted from restricting him in drink, he was allowed to take as much of water, or barley water, as he pleased. He had not, however, complained very much of the restriction in this respect, and was very desirous to act up to the prescribed course.—4th, *Morning.* Again drowsy. *Evening.* Seized with convulsions, and shortly afterwards became comatose; pupils dilated and insensible, with stertorous breathing. Bled to ℥x, the pulse being at the time not full, but quick and sharp. Much relieved by bleeding; coma removed, and consciousness and speech returned in a quarter of an hour. Mustard to feet, to have tinct. canthar. with Sp. ether. nit. in

camphor mixture every third hour, with the view of restoring the accustomed diuresis.—5th, *Morning*. Conscious, still has some headache. Continue the diuretic mixture, and let him take a black draught immediately.—6th. Again in a semi-comatose state; pupils dilated with stertor and sighing respiration, indicative of cerebral effusion, six leeches to temples, mustard to feet, and cold to head. The coma became more profound, and he died at 9 p.m.

Sectio Cadaveris, fourteen hours after death. The abdomen only was opened, as we feared that the body might be removed before an examination could be made. The liver, stomach, intestines, &c., all healthy, heart healthy, but small. All these organs, and the whole interior of the cavity, resembled those of a boy scarcely arrived at puberty. On looking for the kidneys they were found to be reduced to mere sacs of from twice to thrice the extent of the healthy kidney. There was a complete absence of all proper parenchymatous substance, both tubular and cortical; the sacs being divided into a number of cells by the intertubular septa which occur in the fœtal state. The walls and septa were formed of strong fibrous tissue, lined with what appeared rather serous than mucous membrane, and the cavity and ureters contained a small quantity of the same urinous fluid which had been passed during life. The ureters were so much dilated that that on the right side was at first mistaken for the ascending colon, as it was bound down by processes of peritoneum in the situation of that intestine. The circumference of the ureter varied from three to four and a-half inches. The kidney and ureter of either side were almost precisely in the same condition. The bladder was pyriform in shape as in childhood, raised into the abdomen, and its walls were thickened. The bladder, left ureter, and kidney were removed *en masse,* blown up, and varnished. The urine in ureter and sacs was tested for urea by evaporation and nitric acid without result. On closer examination no proper kidney substance could be discovered, nor did it appear that there ever had been any tubular or cortical portions; here and there were a few hard cartilaginous masses of very small size, closely adherent to the membrane forming the sac. I do not find any note of the condition of the supra-renal capsules, which I attribute to the haste with which the inspection was made.

The question which first presents itself for solution is, how long had this sacculated condition of the kidneys (if they can be called by that name) existed? Have we here a congenital malformation to do with, or had the structure of the organs been gradually destroyed and discharged along with the urine,

as in another case of enormous succulated kidney, of which I have notes? There was no history of scarlatina, severe lumbar pain, bloody urine, nor anything indicative of active destructive disease of the kidney. For my part, I am disposed to view the case as at least in great part congenital; since such an amount of destruction of the kidney substance could scarcely have gone on without giving some evidence of it, either in the urine or in the general health. All the organs had a child-like appearance. The urachus was still in situ, and the bladder was like that of early childhood. Another point of interest is, the generally fair health of the lad notwithstanding the low specific gravity of the urine. I am sorry that the urine was not tested for urea previous to the supervention of the symptoms of uræmic poisoning. Supposing, however, that when in health it contained an amount of urea proportionate to its specific gravity, the excessive quantity of fluid would bring up that of the solids to an equality with urine of the specific gravity of 1020–28. It is worthy of remark, that the density, instead of increasing with the diminution in quantity, fell from 1007 on admission to 1004, when there were only five pints; and to these combined circumstances the disturbance of the brain by the accumulation of urea, or of some substance into which its elements had been converted, was probably due. There was here also the same disordered state of the stomach, towards the end of the disease, as is recorded in most cases of Bright's disease. As the urine diminished diarrhœa set in, and probably supplemented, to some extent, the diminished discharge of solids by the urine.

I could not divest myself of all sense of rashness in having reduced the quantity of fluid allowed for drink; yet this was done tentatively, and the boy did not appear at first to suffer much from it. No one, however, could have suspected such a condition of the urinary apparatus, and therefore we were justified in testing the correctness of the notion that the disease depends rather upon some condition of the system causing excessive thirst, than upon pre-existent organic change in the kidneys. A striking circumstance in this case is, that there was none of that pallor of countenance and puffiness of the skin of the face and extremities which accompany degenerative disease of the kidney. The countenance was rather firm and ruddy, instead of pale and flabby. The heart's action had never been affected by retained secretions; and the body had gone on nourishing and growing under this state of things. It follows, as a necessary result of the consideration of this case, that, as urea must have been formed to some extent by the disintegration of tissue, so it was discharged by the urine, inasmuch as there had been no

persistent diarrhœa previous to coming into hospital; nor was the skin ever active enough to allow of its escape by that channel. Urea must have been secreted by this simple membrane in pretty good quantity, since twelve pints of urine, at 1007, would be equal to three pints at 1028; and, as there was neither sugar, albumen, nor urates, the most probable thing is, that it must have contained a fair proportion of urea. Why did this discharge of urea cease when the drink was diminished? Could these simple membranous sacs not separate urea from the blood except it were presented in a very dilute form? It would seem so; and here, I think, we catch a distant glimpse of the final cause of the extreme thirst which always accompanies this disease. In many cases of fatty kidney, and of chronic desquamative degeneration (I cannot call it *nephritis*), the quantity of urine is known to increase, and the specific gravity to become lower, in the latter stages of the disease. If we look upon the case just narrated as one of degeneration, then doubtless we must believe that the quantity of water in the urine was increased as the secreting surface lost more and more of its specific character, and became reduced to a mere exhalant membrane.

Space will not permit me to pursue the chain of induction into the various ramifications of physiological and pathological importance, of which this and other cases of hydruria, however caused, form the links. I can only re-echo Dr. Eade's recommendation that all such cases should be strictly observed, and, if possible, followed out to their fatal terminations, in order that our knowledge of the pathological states upon which they are dependent may be rendered more complete than in, our present comparative ignorance, is the case.

ANEURISM OF THE ABDOMINAL AORTA.

By Jeffery A. Marston, M.D., Assistant-Surgeon, Royal Artillery.

Gr.—J. T., ætat 34, admitted 29th October, 1859. During the months of May and June, he had been confined as a prisoner in the guard-room, for desertion, awaiting some decision from the home authorities. He dates his present illness from about that period, and came into hospital in July, complaining of "rheumatic pains," affecting the muscles of the back. A few days' rest, and the application of opiate liniments

appeared to set him all right, and he returned to his duty. Upon 29th October he was re-admitted. He was an old soldier, and had seen much service; of tall stature, spare frame, and having a sallow cachectic aspect. He gave the following symptoms and history:—A very irregular state of the bowels, needing a constant recourse to purgatives, hemorrhoids, and dyspeptic symptoms, but he chiefly complained of a great pain in the right iliac region, extending down to the right testicle and thigh. He also suffered from pain in the neighbourhood of the right kidney. He described these abdominal and lumbar pains as of a spasmodic and colicky nature. His pulse (remarkably small) was 85. There was no pyrexia. A good deal of fulness, and tenderness upon deep pressure, existed in the right iliac region. The abdomen was tympanitic. The right testicle retracted upwards, towards the external ring, and was very tender. Both inguinal canals were patent. The stomach was distended with gas, hepatic dulness normal. No evidence of thoracic disease was adduced by physical examination. He had never passed bloody urine—a calculus—nor had he ever been troubled with his "water."

Deep pressure of the upper part of right lumbar region gave pain, but neither succussion nor percussion of the spinal column gave any.

He was ordered to be cupped over the right kidney; to have a warm bath; and a purgative, to be followed by an opiate.

30th.—No improvement—bowels not opened; pain and tenderness just the same; small intestines and stomach distended with flatus; right testicle and the whole neighbourhood of Poupart's ligament tender to superficial and deep pressure. No pyrexia. The urine (of which he was passing a very large amount) was highly acid to litmus, sp: gr: 1022, non-albuminous.

Ordered calomel, gr. vj., immediately, to be followed by ol. ricini ℥ss., and enema of warm water.

31st.—Symptoms augmented in severity; bowels but slightly moved, the stool being liquid, and consisting in great part of the injection. The tenderness in right iliac region marked. He made the observation, that *he was sure his food stopped there, and that his disease was there also*. His features were rather pinched; the expression anxious; pulse 104, very small; some increase of temperature over the abdomen; urine very copious in quantity; sp. gr. 1020, and, non-albuminous, depositing crystals of uric acid on standing. Ordered 24 leeches to the right ileum; fomentations to the abdomen, and pulv. opii. grj. every second hour.

November 1st.—Says that he feels better; has slept by means of the opiate. Pulse 110, small; bowels not moved; belly very tympanitic; has vomited 2 or 3 times, perfect anorexia; the insertion of the finger upwards towards the internal inguinal ring gives him pain; the urine of the same character and amount.

To continue the opium and fomentations. A long tube was passed up the large intestine, and as much warm water injected as he could permit. The distension caused by this, seemed to give him pain. It came back tinged with fæces, and some lumps of fœcal matter were removed.

November 2nd.—About the same; but narcotized by the opium. A long tube was again passed, as high as possible, and a repetition of the enema. It acted copiously; the fœcal matter was yellowish, very liquid, and diffused through the injection; two figured portions were observed.

After this he seemed very much improved; the fulness, distension, and nausea vanishing; he slept spontaneously, and remarked that he "should now shoot with the best of them." The unfortunate fellow was a capital rifle shot.

During the 3rd, 4th, and 5th, he continued tolerably well; the bowels acting by castor oil; but there still existed pain in the inguinal region and upper part of the thigh. The pulse was 80, of same character. During one of these days, *he jumped from off the bed to the floor, but did not appear inconvenienced nor pained by the shock.*

Upon 6th he was evidently getting worse; the bowels acting imperfectly; there was a good deal of distension and uneasiness after eating. He complained of the same pain, which had more of a neuralgic spasmodic character. The most careful examination of abdomen failed to detect any tumour. The urine continued very copious. At this period he complained of pain also in the back and left lumbar region, beneath the lower ribs. Percussion and auscultation down spine elicited nothing satisfactory.

To have castor oil and to recommence the opium.

7th, 8th, and 9th.—The bowels acting sparingly by castor oil, and enemata. He still complained of pain and sense of obstruction in right iliac region, but more particularly of dyspeptic symptoms, acid eructations, and "gripes," after taking food. He was relieved by a mixture of hydrocyanic acid, soda, and calumba.

10th to 14th.—Not progressing favourably, but still tolerably well. Complains as before, as well as of the left lumbar region.

15th, 16th.—Constipation appeared to be the most marked symptom; great fulness and distention of the abdomen, and pain in the same regions. The uneasiness after eating or drinking, much increased. He vomited occasionally. The urine, copious and clear, as before. Deep pressure with the stethoscope in the epigastric region elicits a fine friction-murmur, attending the movements of the diaphragm. This was heard by more than one ear.*

We continued the hydrocyanic and soda mixture, with opium, and the application of fomentations to the belly. Upon the afternoon of the 16th, by his own desire, a large injection was given, which only brought away some yellow fæces. Between 8 and 9 P.M., same day, he went to the night-stool and died suddenly, apparently by syncope.

During the treatment, he was placed upon milk diet, with an occasional mutton chop, beef tea, and a regulated allowance of wine, and cold brandy and water.

Post Mortem.—Head not opened.

Pericardium contained about 1 oz. of fluid; *heart* small, healthy; cavities nearly empty. *Aorta* had spots of atheromatous disease.

Old pleural adhesions right lung; emphysema of pulmonary substance.

Left pleural sac contained nearly a gallon of blood, partly coagulated, partly fluid; the posterior part of the diaphragm was pushed upwards by an aneurismal tumour. Through the centre of this projecting diaphragm and contiguous pleura, was an ulcerated opening, about the size of a fourpenny piece, through which a probe might be passed into the aneurismal sac. Continuing the dissection, by removing the stomach and liver, and cutting through the diaphragm, towards the aortic opening, an aneurismal tumour springing from the aorta, just as it became abdominal, was perceived. The aneurism was of large size, apparently bilobed, and lying upon either side of the vessel. The sac rested posteriorly upon the 3 lower dorsal, and 2 upper lumbar vertebræ, the bodies of which were considerably eroded.

The parts were so agglutinated and altered, that it was very difficult, indeed almost impossible, to dissect them well. The aneurismal sac was compressed in the centre, projected laterally,

* Dr. Stokes particularly reverts to the absence of any friction-murmur from peritoneal inflammation in cases of abdominal aneurism. In his differential diagnosis of this disease, from other abdominal affections, simulating aneurism, he says that he has never met with friction phenomena in the latter disease.

the projection upon the right side being much the smaller, and that on the left larger and projecting upwards into the left pleural region. There was a free communication between the aorta and the left part of the sac, by an oval opening, the edges of which were atheromatous, and ragged.

The whole tumour was laterally in connection with either kidney, both semilunar ganglia being involved in the parietes of sac. On the left side, it nearly touched the spleen. Anteriorly (beside the layer of peritoneum behind the lesser omentum, which was agglutinated to the sac) were the stomach, part of the liver and duodenum.

Besides resting upon the bodies of the vertebræ, it rested upon the psoæ and quadrati lumborum muscles, involving the upper branches of the lumbar nervous plexus.

The stomach was greatly distended, as well as the small intestine, and the latter contained a large quantity of liquid fæces. The larger intestine was empty and contracted, and no impediment to fœcal flow was discovered.

With the exception of some venous congestion of the kidneys, the remaining organs were healthy, the aorta had numerous spots of atheromatous disease.

Remarks.—Wise as I now am after the fact, I feel something more than a tinge of regret that I was so little skilled in the interpretation of the phenomena as not to have diagnosed their import. This man was watched anxiously, and examined very carefully, and although the case presented difficulties, I fear that some foreconceived notions on my part may have biased my opinions.

I shall succinctly trace the varying phases through which these opinions passed. At first the lumbar pain, retraction and tenderness of the testicle; the quantity of urine; the neuralgic, and apparently spasmodic nature of the pain, led me to infer the passage of a renal calculus from the right kidney.

Then lumbar and psoas abscess, passed through my mind. Aneurism certainly crossed it, and was, indeed, mooted once, by my brother Assistant-Surgeon, but the seat of pain (chiefly right side), the prior history of the case, the symptoms, the absence of tumour and stethoscopic evidence, all tended to render the existence of that disease improbable. There were none of those attacks of violent paroxysmal abdominal pain, so ably pointed out by Dr. Beattie, as suggestive of abdominal aneurism.

My mind reverting to the history of chronic constipation and dyspepsia, the local tenderness, its persistence, seat, the man's own feelings, the quantity of urine, the absence of any

early vomiting, the tympanitic distension, and the great relief to all the symptoms, after the free action of the bowels, led me to infer, that some stricture existed in the neighbourhood of the cœcum, from a chronic cause. However, his mode of death, and the autopsy, proved how wrong I had been.

The case is one of interest, and the apparently intricate phenomena will bear unravelling.

I.—The dyspeptic symptoms were due probably, in part, to the mechanical effect of the tumour upon the stomach and duodenum, in part to the irritation and pressure upon the solar sympathetic plexus.

II.—Constipation. There was much liquid fæces and gas in in the small intestines, the larger being empty. Now some physiological experiments recently instituted,* go to show that irritation, galvanism, and section of the abdominal sympathetic, affect the peristaltic movements of the smaller bowels, either increasing or destroying it, according to the nature of the experiment.

I would venture to suggest that imperfect or abnormal innervation of the small intestine, was the cause of its imperfectly exercising its function.

III.—The *urine.* I could not account for the great amount of urine passed, and its relatively high sp. gr. during the lifetime of the patient, but I conceive this to have been, in part, due to rapid metamorphosis of tissue (for he was wasting much while under treatment), and the fluid nature of the food, in part also, to the effect which the pulsating sac must have exerted through the sympathetic ganglia, splanchnics, and plexuses, upon the vaso-motor renal nerves.†

IV.—The pain and tenderness affecting the right iliac region, testicle, inguinal canal, and front of thigh. This will be disposed of by a consideration of the anatomical relations of the tumour to the lumbar plexus; the neuralgic pain being in the course of, and at the periphery of the genito-crural, ilio-inguinal, ilio-hypogastric, and external cutaneous nerves, of that plexus.

* Some recent experiments tend to show that the peristaltic action of the small intestines is under the influence of the sympathetic system. Galvanism of the ganglia and splanchnic nerves produced evident contraction of the muscular coats. The large intestine appeared to be less under the influence of the same nervous system.—Vide researches of Pflüger and Mr. Lister. A paper by the latter, in the Proceedings of Royal Society, London; vol. ix., No. 32.

† Brown Séquard—Lecture, vide Lancet, November 27, 1858. "The Influence of the Nervous System upon Secretion, Nutrition, and Animal Heat."

INSTRUMENTS, PROCESSES OF INVESTIGATION, &c.

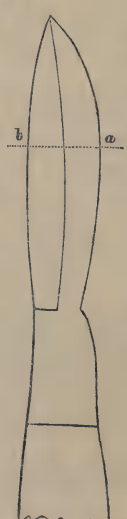
KNIFE FOR OBTAINING THIN SECTIONS OF SOFT TISSUES.

By R. Lawson, Deputy Inspector-General.

It is often of importance to obtain sections of the softer animal tissues, whether healthy or diseased, sufficiently thin for examination with the higher powers of the microscope without previous preparation. Having failed to effect this with any of the ordinary forms of knife in use, a modification of the common scalpel seemed to offer the best prospect of attaining the object. After some trials I have been led to adopt the following, which can be made by any instrument maker :—

A blade of ordinary size is to be forged and ground so that the half next the edge on one side is in the same plane with the part attached to the handle, and the half next the back removed, as represented in the figure and section. The opposite side of the scalpel is to be finished in the usual manner. The flat surface of the blade should be completed on a fine hone, and in setting, the opposite side, will require to be held at an angle of about 30° with the surface (as shown in the section), or about twice the usual angle for ordinary scalpels, as otherwise the edge will be so weak that it will not stand.

Section through *a b* four times enlarged.



The figure represents a knife with the flat surface on the right-hand side, and adapted for cutting towards the operator.

The instrument may be made with the flat surface on the opposite side, should he prefer cutting from him. The latter course, in fact, offers most advantages.

If the edge of this knife be kept keen, any one with a little practice may obtain sections of fresh tissues with it, so thin that they can be readily examined with a quarter or even an eighth of an inch objective, without further preparation than merely placing them in dilute glycerine. These sections cannot be made so extensive as those obtained by the double knife, but then other advantages are more than sufficient to compensate for this. It will be found that the blade from *a* towards the point will make the best sections.

FORMULA FOR A NEW TRANSPARENT CARMINE INJECTION.

By T. A. Carter, M.D., Physician to the Warwick Dispensary, Leamington.

In Dr. Beale's work on "The Microscope in Clinical Medicine," it is stated that Mr. Smee has produced very successful injections of the capillaries of the brain with an ammoniacal solution of carmine. Having occasion to use a coloured transparent injection some time ago, I made trial of this solution, to which I added a certain amount of gelatine. In my hands, however, it failed most signally; the colouring matter passed through the coats of the blood-vessels, and stained the surrounding tissues in such a manner that the capillaries could not be distinguished. Having made repeated experiments with this fluid on various organs, and having as repeatedly failed, I came to the conclusion that a satisfactory result was of too rare occurrence, and depended too much upon the physical and chemical condition of the tissues, to induce me to expend more time and material in such fruitless endeavours. Reflecting on the acid nature of carmine, and its sparing solubility in water, it occurred to me that if it were precipitated from its solution in ammonia by an acid, it might be obtained in a state of division sufficiently minute for penetrating the capillaries, and that in such state it would not be liable to colour the blood-vessels and surrounding parts. I accordingly dissolved a little carmine in dilute caustic ammonia, and added to the solution, drop by drop, some weak acetic acid, until precipitation ceased. On placing the precipitate under the microscope, however, it appeared to me that the flocculi were

much too large to traverse the finest capillary vessels. I did not, therefore, proceed further with this experiment, but determined on trying the effect of throwing down the pigment in the solution of gelatine, as I imagined that by so doing the aggregation of particles might be prevented. This surmise proved to be correct; for, on examining the injection so prepared, it appeared to be perfectly homogeneous, and without the faintest trace of granularity. It was, moreover, found to run freely through the blood-vessels without tinting the tissues in contact with them.

The following is the formula which I have found from ample experience to yield the most satisfactory results :—

Pure carmine ʒj.
Liq. ammon. fort (P.L.) ʒij.
Glacial acetic acid (50° Fr.) ʒj M. xxvj.
Solution of gelatine (1 to 6 water) ℥ij.
Water ℥iss.

Dissolve the carmine in the solution of ammonia and water, and filter if necessary. To this add ℥iss of the hot solution of gelatine, and mix thoroughly. With the remaining ℥ss of gelatine solution mix the acetic acid, and then drop this, little by little, into the solution of carmine, stirring briskly during the whole time.

If properly prepared, this injection will, I believe, be found to be the most penetrating one that has yet been introduced. With it I have succeeded in filling the capillaries of the brain, spinal cord, eye, tongue, periosteum and bone of the mouse; the lungs, liver, pancreas, kidney, and other organs of various domestic animals. Tissues injected with this fluid may be mounted either in Canada balsam, weak spirit, acidulated glycerine, or other preservative fluid, which will not dissolve or act injuriously upon the carmine or gelatine.

HŒMATOXYLIN TEST FOR AMMONIA.

Take a piece of logwood, cut it up, scrape or rasp it (old shavings will not do, because they are chemically changed by light and air), and make a tincture with 4 oz. alcohol and 12 oz. water. Add 20 grs. of alum, which must be free from iron, and a filtered solution of 3 dr. of fused chloride of calcium, slightly acidulated with muriatic acid. After mixing, add three or four drops of hydrochloric acid, or so much dilute hydrochloric acid as is necessary to give paper, moistened with this tincture, a peach-blossom tint; should the moist paper be purple, more

acid will be required; if it be orange-coloured, too much has been added. The paper must be carefully purified before it is moistened with the tincture in the following manner:—

Take foreign letter-paper and steep it for 24 hours in pure dilute hydrochloric acid; then wash it 20 or 30 times in water or dilute acid till every trace of iron is removed. Steep subsequently for some hours in distilled water and ammonia, and dry rapidly (stove). The tincture for moistening the paper thus prepared must always be perfectly fresh. The coloured paper must be rapidly dried at a stove, be densely packed in small hermetically closed bottles, and the latter be kept excluded from light. Without all these precautions the test is useless.

NESSLER'S TEST FOR AMMONIA.

Add a solution of iodide of potassium to a solution of bichloride of mercury until the precipitate is almost redissolved, filter, add solution of caustic potash in excess to the filtrate. Allow to stand—filter. The clear liquid obtained is the test, which gives a brown reaction upon the presence of ammonia.

Quantitively this may be employed as follows:—The dried precipitate contains 1·7 of ammonia in 55·9. If desired to test for ammonia in water, the water had better be warmed to a little below its boiling point.

TAPE-WORM FROM EATING MEASLY PORK.

[*Extract from a letter from* DR. MARSTON, *Royal Artillery.*]

"You know that the whole history of the genesis of the Cestoid Entozoa has been tolerably well traced, from the cystoid and immature form up to the higher grade of morphosis—by Küchenmeister particularly, who had the conscience to feed an unfortunate criminal with "measly pork" before his execution. In Malta, tœnia is very common. We must have had fifty cases at least in the Royal Artillery; and in almost all we found that the men had eaten underdone or raw rations of pork. In two cases of Tœnia affecting infants under nine months (one was under six months), at the breast—the mothers told me that they had allowed the infants to suck ration pork."

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EXPLANATION OF THE PLATES.

Plate I.

To Illustrate Mr. Lockhart Clarke's Observations on the Structure of the Cord in a case of Muscular Atrophy accompanied with Disease of the Cord (p. 13).

Fig. 1. Transverse section of right lateral half of the grey substance of the spinal cord, with the anterior and posterior commissures, at the upper third of the cervical enlargement. A, *a*. *Caput* cornu posterioris. *a*. The *gelatinous substance*. B,B′. *Cervix* cornu posterioris. B. Group of cells called the posterior vesicular column. B′. Longitudinal bundles of the cervix. D. Anterior grey substance or cornu. C,C. Anterior or motor nerves connected with it. *e*. Anterior median fissure, at the bottom of which are the decussating fibres of the anterior commissure *f*. Central canal, closed in this section by a mass of epithelial nuclei. *g*. A somewhat triangular spot of finely granular degeneration on the left side of the posterior commissure. *m*. A much larger lesional space, in the middle of the cervix cornu, and containing two blood-vessels. *n*. Another at the base of the cervix cornu, between the anterior and posterior commissures, and also containing blood-vessels. *o*. An oval lesional spot, at the posterior and inner part of the *cervix* cornu, and encroaching on the base of the *caput* cornu. × 34 diameters, but reduced one-half from the drawing.

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Fig. 3. Delicate fibres seen on other parts. These formed an inextricable interlacement, in the muscles of which lay a number of the oval cells represented in fig. 1.

Plate IV.

To Illustrate the Structure of certain forms of white Fibrous Tissue.

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Fig. 2. *d* small piece of one of the cords represented in the upper part of fig. 26 at *b*. Several nerve fibres are seen, and in the upper part of the drawing some very fine fibres. These are probably altered nerve fibres.

At *e* another portion of a true but very fine nerve fibre is represented. Three distinct fibres are in a clear transparent matrix, the so-called tubular membrane. *f*, a portion of one of the finest cords in fig. 26. Nuclei with branching fibres are seen, and the distribution of these is very similar to that of the fibres represented in the upper figure.

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Plate V.

To Illustrate the Structure of certain forms of Fibrous Tissue.

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b. Appearance of fine fibre of yellow elastic tissue under the same power.

c. Fibre stretched in a longitudinal direction.

d. Appearance generally observed in unstretched tendon.

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Plate VI.

Illustrating the Structure and Growth of Cartilage.

Fig. 15. From the frog.

a. Very young cartilage composed of oval masses of germinal matter, separated by a small quantity of soft and imperfectly formed intervening substance.

b. One of the masses of germinal matter which exhibits an outer portion which is only slightly coloured by carmine, and a central part more darkly coloured. The outer portion is gradually becoming converted into matrix.

c. An elementary part showing zones of different ages. The outermost only is perfectly-formed cartilage. Next come layers of germinal matter, which are slowly undergoing conversion into cartilage, and lastly the *nucleus* is seen in the centre of the mass.

d. An older elementary part, consisting of fully-formed cartilage, recently-formed cartilage, germinal matter, and the nucleus.

e.—Shows that not only does the germinal matter undergo conversion into cartilage at its external surface but that this alteration may occur as well in *the central part.*

f, g.—Show the same change in a still greater degree.

h.—Marks the position originally occupied by the germinal matter of cartilage, but this substance has entirely undergone conversion into matrix. The nucleus is dead and is therefore no longer coloured with carmine.

Fig. 16. Is a thin section through the temporary cartilage of the os calcis with the periosteum and tendon inserted into it. *a.*—Is the cartilage. The masses of germinal matter result from division, and some are seen actually undergoing the process, but in all cases the resulting masses are at once separated from each other. *b.*—Corresponds to the periosteum. Here stellate masses of germinal matter are observed, the processes of which are continuous. These also result from the division of masses of germinal matter but unlike those of cartilage, the resulting masses remain for some time continuous with each other. *c.*—Marks the tendon in which the masses of germinal matter are continuous but arranged linearly and not in the form of stellate masses as in the periosteum. *a.* near the centre of the figure marks a capillary vessel.

Fig. 17. Shows the structure and mode of development of cartilage in the mouse, and illustrates the manner in which fatty matter is deposited in the 'cells.' From the ensiform appendix of a young white mouse. The figures *a, b, c,* very much resemble those in the upper figure. *d.*—Germinal matter and nucleus with a small oil globule deposited in the germinal matter. *e.*—The same, but the oil globule has increased in size. *f.*—A further stage of the same change. The germinal matter and the nucleus are now seen lying between the globule of fatty matter and the formed material (wall of the cartilage cell). This is the position corresponding to that which the nucleus occupies in the fat vesicle and the primordial utricle in the 'starch-cell.'

Plate VII.

To illustrate the mode of formation of lacunæ and the process of calcification of bone. *Page* 82.

Fig. 18. Thin section of recently-formed bone with the periosteum. From the femur of a kitten one day old. *a.*—Areolar connective tissue on the outer part of the periosteum. *b.*—More compact tissue. In both these portions stellate masses of germinal matter are seen connected together by processes. These are usually termed connective tissue corpuscles. Capillaries are seen in this part of the drawing and numerous nuclei connected with their walls. *c.*—Is the inner layer of the periosteum, and here oval elementary parts can often be isolated. In fig. 44 these are represented much more highly magnified. As these grow, the soft-formed material increases, and the distance between the nuclei of these elementary parts of course becomes greater. *d.*—Shows the manner in which the formed material of the above becomes calcified. The calcareous matter is deposited in the oldest part of the formed material, and gradually increases from without inwards, towards the nucleus. Thus each nucleus becomes enclosed in a space, and the space gradually becomes less until the calcareous matter extends very close to the laçuna. The calcareous matter is doubtless incorporated with the matrix, and during this process, spaces are left which become the canaliculi. *e.*—Shows how the further deposition of calcareous matter takes place, and gives to the space a stellate appearance, which increases until the lacuna assumes its perfect characters.

Fig. 19. Elementary parts from the inner part of the periosteum marked *c* in the last figure.

Fig 20. A small lacuna in process of formation. Globules of calcareous matter are seen still retaining their spheroidal shape in some places, while in others the formation of the bone with the canaliculi is complete.

Fig. 21. A small lacuna still further from the periosteal surface almost perfectly formed.

Fig. 22. Two lacunæ from the femur of the kitten.

Fig. 23. Two lacunæ in the recently formed bone of the femur of the kitten. The germinal matter has undergone division, and a number of small elementary parts have been produced. These are increasing at the expense of the inner part of the lacuna. Thus the space gradually increases in size and becomes filled with small granular bodies. Several of these enlarged lacunæ run together and ultimately a space of considerable size results and the little granular 'cells' become the narrow cells which occupy the space.

Fig. 24. Cancellated structure from the first phalanx of the great toe of a girl about 16 years of age. *a.*—Portion of fully-formed bone. About the central part of the figure it would appear that the bone is being gradually removed. To the right a lacuna is being formed. Globules of calcareous matter are still seen, and immediately below, on a line with *b* several elementary parts are observed which have not yet undergone the process of calcification. *c.*—A capillary vessel with nuclei in its walls. Close to the vessel are oval masses of germinal matter surrounded with soft formed material. At *d* this formed material exhibits a fibrous character. *e.*—Large bodies composed of several elementary parts in process of growth. *f.*—Is growing in a curve. These are the so-called myeloid cells. They may become calcified and thus take part in the development of the spiculæ of bone which exist as imperfect septa between the cancelli. The nuclei in these masses, which are in a state of active growth, are tinged of a much darker colour by the carmine than those around them.

Plate VIII.

To illustrate the formation of the lacunæ of bone and the 'tubes' of dentine. Pages 82, 87.

Fig. 25. Cartilage of the temporal bone of an adult frog prior to ossification. Two of the masses of germinal matter

are undergoing division. The *septa* are not produced by the *growing in* of the matrix, but the outermost part of the germinal matter is converted into the so-called matrix.

Fig. 26. Another portion of the cartilage in which calcareous matter has been deposited. Globules of every size may be observed from the smallest visible particles to the large masses shown in the figure. The germinal matter is undergoing conversion into the formed material or matrix, and this is gradually becoming impregnated with calcareous salts. It must be borne in mind that the deposition of the calcareous matter always commences in the oldest portion of the formed material, which lies midway between the several masses of germinal matter.

Fig. 27. Shows a further stage of the process of calcification from the frontal bone of the frog.

Fig. 28. Two lacunæ from the frontal bone of the frog in process of formation. The spaces which are seen between the globules in this and in the last figure, gradually become narrower, and ultimately assume the characters of canaliculi.

Fig. 29. One third of the inner part of the wall of a fully formed lacuna near the periosteum. From the frog. A portion of the nucleus is represented in the lower part of the drawing to the right, and a number of separate globules are seen. These increase in number and size, and they coalesce at certain points and gradually encroach upon the nucleus. Magnified 1700 diameters.

Fig. 30. Two recently formed lacunæ and part of a third, from the frontal bone of the frog. The manner in which the canaliculi gradually become narrower proceeding in a direction *from* the nucleus, is well seen. As the lacunæ increase in age, the wide portions of the canaliculi which open into them gradually become contracted.

Fig. 31. A fragment of osseous tissue torn from perfectly formed bone from the frog. The canalicular tubes between the masses of calcareous matter are shown.

Fig. 32. Is a thin section of the inner portion of the dentine, and the surface of the pulp from an adult incisor *a.*—Where calcification is complete. To the right of this dark

portion the manner in which the calcareous matter is deposited in the matrix, is represented. Three distinct globules are seen. One of the so-called tubes traverses two of them. *b.*—Shows the uncalcified matrix or formed material. *c.*—Oval masses of germinal matter with formed material on their outer surfaces. *d.*—Terminal portions of nerve fibres.

The so-called tubes are seen to be occupied with soft processes which extend from the oval masses of germinal matter on the surface of the pulp, throughout the 'tubes.'

At *a* in the lower part of the figure one of these masses is torn out entire. It was continuous with the so-called matrix and would in great part have undergone calcification. It becomes much narrower as the tooth advances in age, and is always narrower at the outer part of the dentine which is the oldest portion, than near the pulp, which part was more recently formed. It is clearly solid.

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Plate IX.

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Fig. 38. A fragment of dentine near the pulp cavity with the prolongations of the masses of germinal matter in part of

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Fig. 39. One of the oval masses of germinal matter on the surface of the pulp with a small portion of the structure prolonged from it. This is surrounded by the matrix about to receive the calcareous deposit, only the inner part of which is torn away with the structure figured in the drawing. A number of small spherical particles are seen in the substance of the matter of which the contents of the 'dentinal tube' are composed $\times 2800$ diameters.

Fig. 40. One of the ganglion cells with nerve fibres connected with it from a nerve distributed to the pericardium of the ox. The large nucleus of the ganglion cell is seen, but in its substance, principally near the surface, a number of small oval nuclei resembling those in the nerves are also visible.

Fig. 41. A small portion of one of these 'ganglion cells' showing the continuity of the nerve fibre with the substance of the 'cell.'

Fig. 42. A portion of a ganglion on the side of a nerve showing ganglion cells and arrangement of the nerve fibres. Figs. 40 and 41 represent two of the 'cells' shown in this drawing more highly magnified.

Fig. 43. Tissue with stellate cells in immediate contact with the cementum of the fang of an incisor tooth. This is described under prep. 52, page 12. Towards the right of the drawing the 'cells' become smaller and the processes or tubes are seen to become narrower; then they appear solid and are lost in the matrix which is gradually becoming impregnated with calcareous particles.

Fig. 44. Muscular 'fibre-cells' from the circular coat of the aorta of a man who died from rupture of the arch. The tissue was torn if only very slight force was employed. These beautiful elementary parts with long radiating processes can hardly be called 'cells.' The processes are certainly fibrous. There is no possibility of distinguishing 'cell wall' and 'cell contents,' but the inner matter which is granular, gradually shades off into the fibrous substance of which the outer part of the processes is clearly composed.

The outer fibrous part of these elementary parts was not tinged by carmine; within this was a layer of tissue slightly reddened, and within this the colour was more intense, while the nucleus, which was situated *furthest* from the carmine solution, was very darkly coloured.

Plate X.

Illustrations to Dr. Eade's paper on diabetes insipidus. Page 127. *Dr. Duffin's abstract of Kühne's observations on muscular contraction, page* 141. *Casts of the seminal tubes found in urine. Page* 136.

Fig. 1. Kidney showing greatly dilated pelvis and calyces, shrunken pyramids, and diminished cortical portion.

Fig. 2. Sartorius muscle of the frog inverted, and partially dipped into oil of 40° centigrade, in order to destroy a portion of the contractile tissue without affecting the nerve fibres passing through the same. After Kühne. Page 153.

Fig. 3. Sartorius muscle of the frog split longitudinally, to prove centripetal conducting power of motor nerves. After Kühne. Page 153.

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Fig. 6. Spermatozoa in casts of the seminal tubules found in the urine of an old man aged 70.

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To illustrate arrangements of clinical microscopes for demonstrating objects to large classes. Apparatus designed by Mr. Hoblyn for pressing down thin glass cover while cements are drying. Pages 138, 140.

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Fig. 2 is the inside view of Fig. 1, and shows the manner in which the microscopes are retained in position. Each horizontal bar of wood can be screwed down upon two microscopes.

Fig. 3. Arrangement for holding four microscopes. The objects may be illuminated by lamps, or by ordinary daylight. A plate of glass is let into the cover; so that, with the aid of mirrors, the apparatus may be used in a room lighted with a skylight.

Fig. 4. Shows the manner in which the microscopes are maintained in their proper positions in fig. 3. *a* shows the position of the mirror, and *b* that of the lamp.

Fig. 5. Represents the arrangement by which various pieces of apparatus may be adapted to the clinical pocket microscope. *a* is the diaphragm. *b* is a sliding tube in which an achromatic or other form of condenser, prism, well, or stop, or polarising apparatus, is made to slide. *c* is the mirror. Each of these pieces is made to slide on a tube, and is prevented from slipping by a little screw.

Fig. 6. Apparatus designed by Mr. Hoblyn for pressing the thin glass on preparations while cements or Canada balsam are drying.

Plate XII.

To illustrate Dr. Marston's Paper on Ophthalmia.

Diagram taken from a case of 'vesicular' lids with slight inflammation. Magnified. The drawing does not give so good an idea of the appearance as could be wished.

Plate XIII.

To illustrate Dr. Marston's Paper on Ophthalmia.

Fig. 1. Appearance of large vesicles removed from outer canthus at the retro-tarsal fold, close to the site of Kraüse's glands, magnified by a simple lens. Three vesicles in stage of vesicular congestion.

Fig. 2. Sago-grain bodies from the lid of G. Etheridge. The bodies had the appearance exactly of Sudamina, so translucent were they; but no collapse ensued upon pricking the vesicles. Obtained by transfixion with fine needle. Lower lid. The collections of cells are not represented sufficiently granular in the drawing.

Fig. 3. Appearance of cells in a small portion of granular lid, raised by a needle and removed. Chronic case. Disease in abeyance. Granulations firm, fleshy, with a smooth surface. Old granulation tissue, like cells upon the deeper wall of a sinus.

Fig. 4. More advanced stage, spindle shaped. Acetic acid has been added.

Fig. 5. Preparation shewing a simple follicle (crypt) from a normal eyelid. The interior contains granular cell-like bodies (masses of germinal matter) × 250. The boundary wall of the follicle is made too distinct and abrupt in the engraving. In nature the demarcation between the contents of the crypt and the surrounding tissue is made out with difficulty.

Plate XIV.

To illustrate Dr. Martyn's Paper on the Anatomy of Muscular Fibre.

Fig. 1. Muscular fibre of the lamb, × 2,000. [Amici].

Figs. 2, 3. Ultimate fibrillæ of striped muscle. [Carpenter].

Fig. 4. True fibrilla of river crab. [Kölliker].

Figs. 5, 6. Fibrillæ, "not true fibrillæ, but Fäserchen;" natural maceration of river crab, the bright zones showing a dark line across them. [Kölliker].

Fig. 7. True fibrilla, undisturbed state, × 1,200 diams. This, as well as 17, 18, 19, 20, is taken from fibre of the pig. [Mihi].

Figs. 8, 9, 10, 11, 12, 13. Various appearances exhibited by fibrillæ "which cannot at present be satisfactorily explained." [Mic. Dict. Art. Muscle].

Fig. 14. Fibre of lobster, in alcohol. [Mic. Dict.].

Fig. 15. Single fibrilla, × 300. [Todd and Bowman].

Fig. 16. Single fibrilla from pig. [Sharpey].

Fig. 17. Single fibrilla, much stretched, × 1,200. [Mihi].

Fig. 18. A double fibril (*b*), much stretched. (Prep. partly by Mr. Lealand). At *c*, a part has broken from the violence used. Faint 'interposed' matter unites the particles, the arrangement of which in the stretched and unstretched parts (*a* and *) is contrasted.

Fig. 19. The part of Fig. 18, marked *a*, seen with an under-corrected object glass.

Fig. 20. A double fibril, stretched, as at 18, *b*; this, and 17 are preparations in proof spirit dissected after 20 hours' maceration.

Figs. 17, 18, 19, 20 are magnified 1,200 diameters. [Mihi].

Plate XV.

To illustrate Dr. Beale's Observations on the Ultimate Distribution of Nerves in the Frog's Bladder, p. 243.

Fig. 1. Finest nerve fibres visible, showing that at the point where a fibre, which appears to be single, meets another fibre running at right angles to it, it gives off branches which pass in opposite directions. The finest fibres must, therefore, be composed of at least two fibres, or single fibres must divide into two branches *a, a, a.*

Fig. 2. Network of pale fibres with nuclei from the surface of the bladder of the frog, the epithelium having been removed. Every fibre represented in this drawing, is seen to be composed of several finer fibres. The bundles of fine fibres divide and subdivide; the same fibres forming part of the boundaries of many spaces, and no fibre passes completely round any one space. The arrangement of these very fine bundles resembles that of the coarser nerve fibres, but their structure is much more transparent, and they are only visible in specimens prepared in a particular way. At short intervals nuclei exist which are connected with some of the fibres, while others pass round them without being intimately connected with them. This drawing was made from a specimen, magnified with the 1-26th object glass (1700 diameters with the low eye-piece). The largest fibre at the bottom of the figure is continuous with the fibre marked *b* in the next figure. (Fig. 3, Plate XVI.)

Plate XVI.

To illustrate Dr. Beale's Observations on the Ultimate Distribution of Nerves to the Frog's Bladder, p. 243.

Fig. 3. Continuity of dark-bordered fibre with pale fibres. The dark-bordered fibre is on the right side, and in this and the other drawings, can be distinguished from the pale fibres, by the manner in which it is shaded. Three large nuclei are seen in connection with the pale fibres. The dark-bordered fibre seems to divide into a bundle of very fine fibres. By the side of the dark-bordered fibre at *a,* is a fine fibre, which runs for some distance close to the dark-bordered fibre, and in the same sheath with it. This fibre is the same as that represented running with the dark-bordered fibre marked *e* in Fig. 6.

Fig. 3 represents the course of the fibres marked *e*, Fig. 6; but at a point about 1-500th of an inch from *e*. Magnified 1700 diameters.

Fig. 4. Another dark-bordered fibre continuous with the network of fine fibres, from the same specimen as those last described. *a*. A fine fibre running with the dark-bordered fibre. *c*. A nucleus with some fibres connected with it, while others from opposite directions, pass behind it and unite to form a compound fibre, and this, a little further on, again divides into bundles, which, as is previously the case, pass in opposite directions (to and from the centre and periphery).

Fig. 5. The terminal portion of the lower of the two dark-bordered fibres represented in Fig. 6, magnified 1700 diameters. The pale fibres continuous with the dark-bordered fibre form a narrower bundle than represented in Figs. 3 and 4, but like these, it passes into the network of pale fibres, and mingles with the subdivisions of the pale fibre, seen at the side of the dark-bordered fibre.

Plate XVII.

To illustrate Dr. Beale's Observations on the Ultimate Distribution of Nerves, p. 243.

Fig. 6. Portion of bladder of common frog, showing the termination of a dark-bordered fibre in fine fibres, which form a network, extending over every part of the organ. The bundles of fibres composing this network, lie on different planes. At the lower part of the specimen numerous fine fibres are seen external to the dark-bordered fibre (*c* and *d*), and these can be traced for some distance running in the same sheath with the dark-bordered fibre and its subdivisions. *a, a*. Capillary vessels with nuclei in their walls. *b*. A small vein with numerous nuclei in its walls. *e*. Dark-bordered nerve-fibre near its termination. Fig. 3 represents the further continuation of this fibre much more highly magnified.

Fig. 7. Mucous membrane of the epiglottis of the human subject, just beneath the epithelium. The capillaries, with their nuclei, are well represented, and in the intervals, are seen bundles of nerve-fibres. The finer branches of the nerves are, however, too fine to be seen in a specimen magnified much more than 215 diameters. From the anterior or convex surface of the epiglottis, page 249.

Plate XVIII.

To illustrate Dr. Beale's Observations on the Termination of Nerve-fibres, p. 265.

Fig. 8. Appearance of tissues in one of the spaces between the capillary vessels represented in Fig. 7. The bundle of nerve fibres represented in the upper corner of the drawing upon the left did not occupy precisely the same position in the specimen, but with this exception, the drawing is a copy of nature. This bundle *a* lies on a plane a little below the surface of the rest of the specimen. These fibres are some distance from their terminal branches. A branch is seen to leave the bundle, cross it, and pass towards the left, with fibres from other parts.

The nuclei represented in the drawing are all connected with branches of nerves. Two triangular nuclei are seen, from each of which fibres proceed in three different directions. Some of these fibres could be followed a long distance, and were at length lost amongst numerous other fibres pursuing the same direction. I believe these nerve nuclei or cells to be terminal. By their division and gradual separation new fibres and nuclei are formed. No true nerve terminations or ends could be made out, and from every nucleus fibres could be traced in at least two directions. At *b* a tolerably thick fibre is observed, and on either side of it a narrow line. These lines, it might be inferred, corresponded to the outline of the tubular membrane of the nerve-fibre; but, upon tracing them for a short distance, they are seen to leave the trunk, and may be followed for a considerable distance as distinct and definite fibres. I have many preparations showing a similar arrangement in the frog, in which the fibres can be actually traced in one direction to a nucleus, and in the opposite one into an undoubted nerve-fibre. At *c* a small portion of one of the finest capillaries is shown, and on either side of it some elongated nuclei, with fibres continuous with them, which are probably nerve fibres distributed to the vessel. The nuclei of the capillary itself are also seen.

The nuclei connected with the nerve-fibres in this specimen all contain oil-globules which have been set free by the action of the acid which was mixed with the glycerine, upon the fatty albuminous matter of which the nuclei are composed. The nerve-fibres have also a granular appearance, which is not represented in the drawing, depending upon the same change. In the frog I have been able to trace very delicate nerve-fibres by the lines of oil globules thus produced.

The appearances observed in the specimen seem to prove that in this tissue the finest nerve-fibres are still arranged, so as to form a plexus or network—many of the component fibres of which, diverging from, and intervening between, nuclei or nerve cells, form networks with very wide meshes. The appearances represented in this drawing closely accord with those observed in the palate of the frog; but in the latter structure the fibres can be followed for a much greater distance, and being fewer in number can be traced over a given space much more easily.

Plate XIX.

To illustrate Dr. Beale's Observations on Nerves; and Dr. Marston's Observations on Ophthalmia, p. 266.

Fig. 9. *a* shows the manner in which nerve fibres are connected with the nuclei in tissues generally. From each of the two extremities of the oval nucleus fibres pass off. These fibres are not single, but consist of several finer fibres. In *b* a fine pale compound fibre is seen to divide into two finer fibres, but these are also compound. *c* shows the manner in which a fibre may pass on one side of a nucleus. In nature these two fibres would be closer together, and the nuclei would not appear to be situated in the centre, but more on one side of the fibre than on the other; magnified about 1,000 diameters.

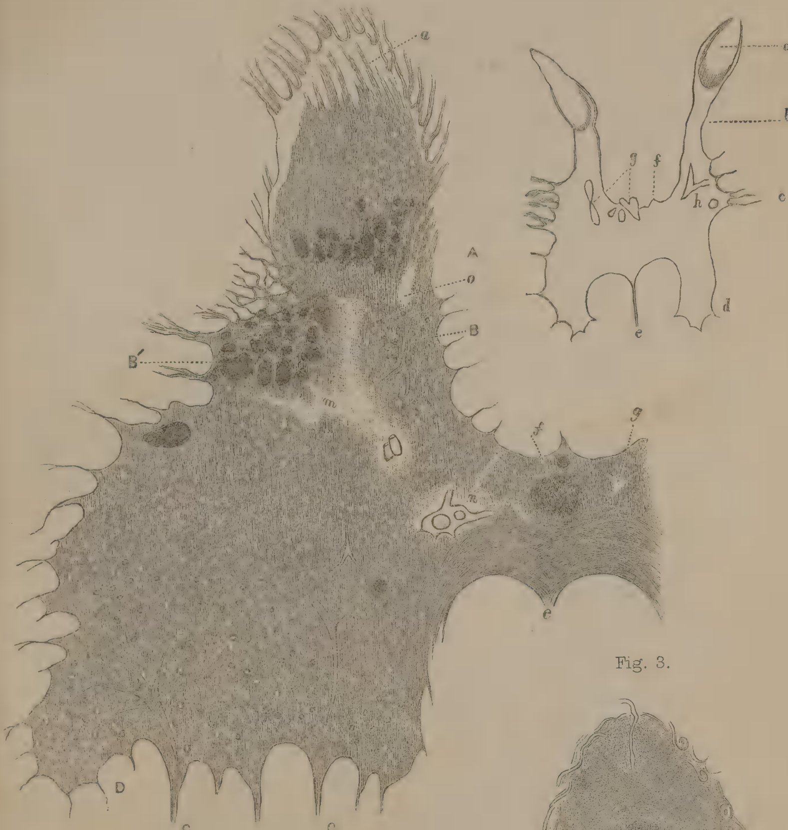
Fig. 10. From the bladder of the frog. Dark-bordered fibre, with nucleus. A fine fibre is seen situated on one side of the dark-bordered fibre, and to moderately high powers this would appear as the outline of the sheath, but it exists upon one side only of the dark-bordered fibre, and gives off the branches represented in the figure; and, therefore, the appearance cannot be explained upon the above supposition.

Fig. 11. One of a few vesicular looking bodies discovered upon the retrotarsal fold of a dead soldier (1860). It closely resembles a crypt or follicle. Are some altered follicles, and others mere cell out-growths from areolated tissue stroma? × 250.

Fig. 12. A semi-transparent granule removed from conjunctiva of the lid. These appeared upon a lid affected with granulation during the stage of convalescence (subsidence). A group of cells apparently situated in one of the meshes of areolated tissue × 250.

Fig. 1.

Fig. 2.

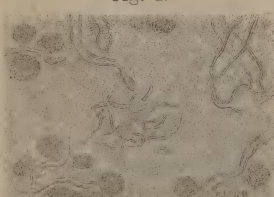


× 34 and reduced ½.

Fig. 3.

× 420 and reduced ½.

Fig. 4.



LOCKHART CLARKE ad nat. del.

Fig. 1.

Fig.2.

Fig. 3.

Fig. 4.

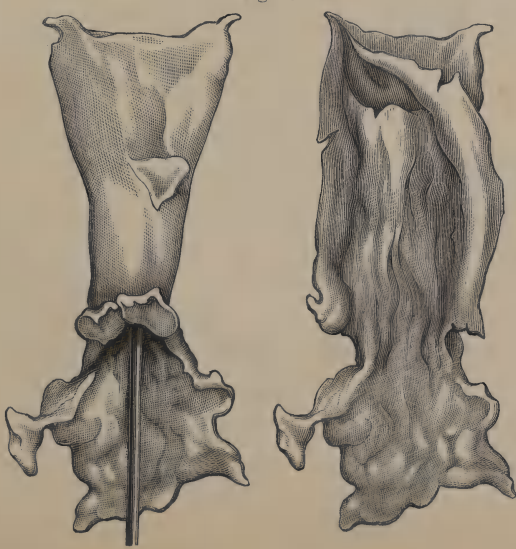


PLATE III.

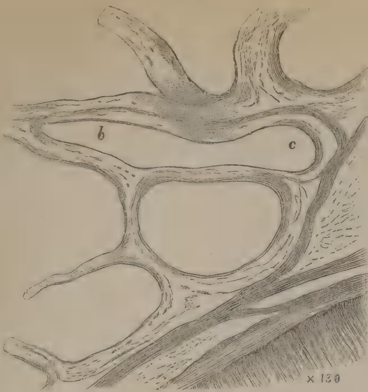
Fig. 1.

Fig. 2.

Fig. 3.

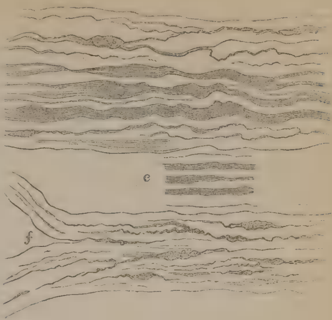
W. ROBERTS ad nat. del.

Fig. 1.



b a

Fig. 2.



× 700

Fig. 3.

Fig. 4.

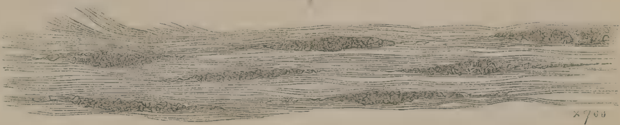
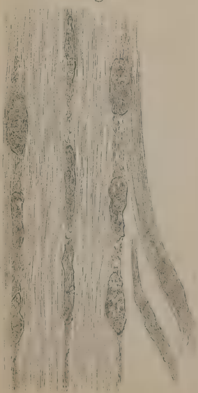


Fig. 5.

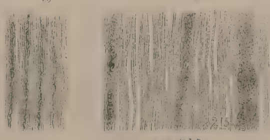
Fig. 6.



× 700

Fig. 7.

a b



× 215

Fig. 8.

a

× 700

1000 ths × 130

1000 ths × 700

L. S. B. 1861.

ARCHIVES.

Fig. 9.

Fig. 10.

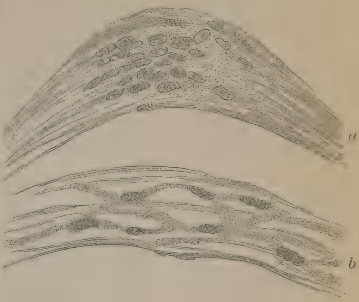


Fig. 11.

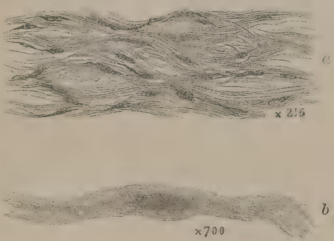
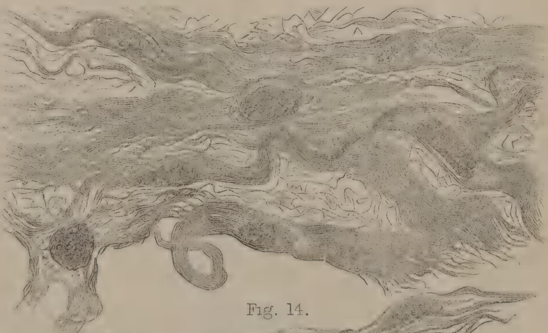


Fig. 12.

Fig. 13.



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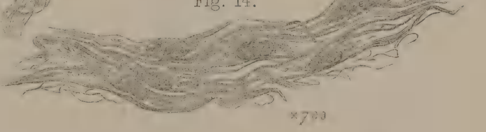


1000 ths × 215

1000 ths × 700

L. S. B. 1861.

Fig. 15.

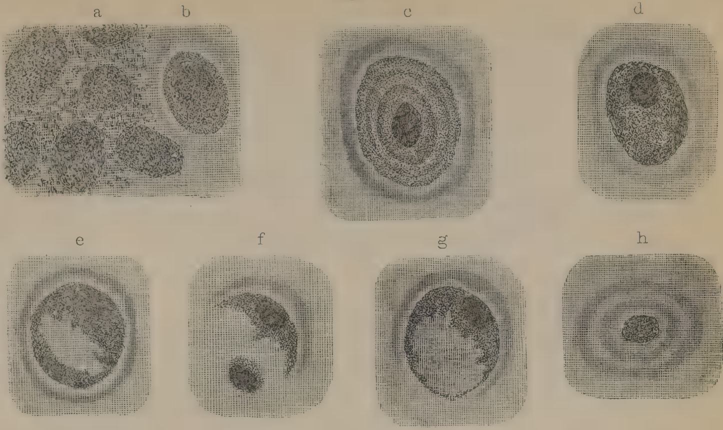


Fig. 16.

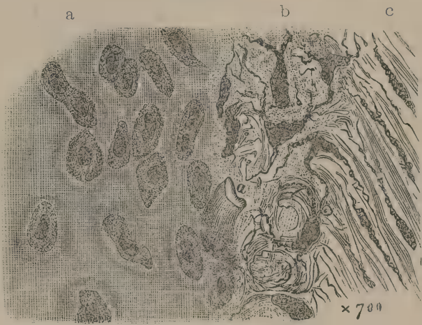
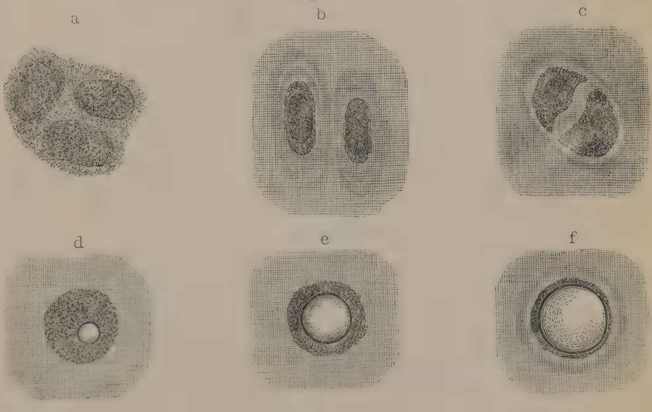


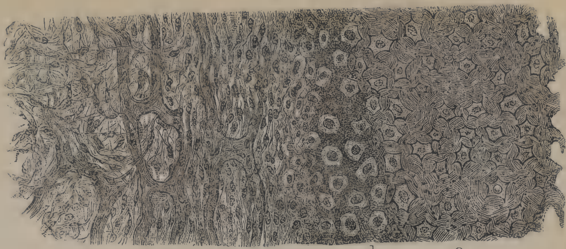
Fig. 17.



L. S. B.

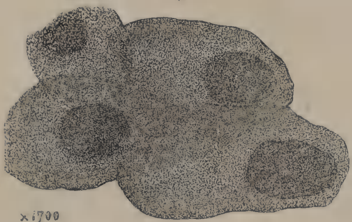
1000 ths × 700

Fig. 18.



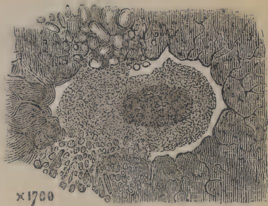
a b c d e × 215.

Fig. 19.



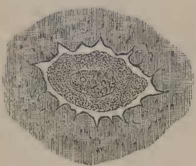
× 1700

Fig. 20.



× 1700

Fig. 21.



× 1700

Fig. 22.

Fig. 23.

× 700

Fig. 24.

a b c d e f × 700

L. S. B.

1000 ths × 700

1000 th × 1700

Fig. 25.

Fig. 26.

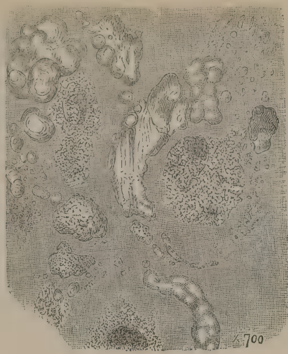


Fig. 27.

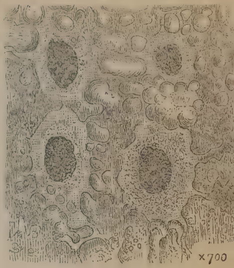


Fig. 28.

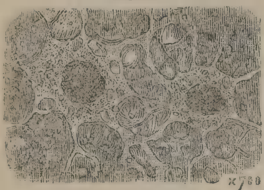


Fig. 29.

Fig. 30.

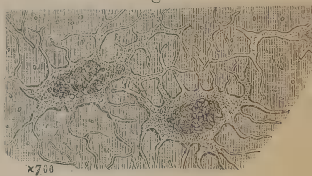


Fig. 31.

Fig. 33.

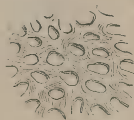


Fig. 34.

Fig. 35.

Fig. 32.

Fig. 36.

Fig. 37.

× 700

1000 ths × 700

1000 ths × 1700

Fig. 38. Fig. 39.

× 2300

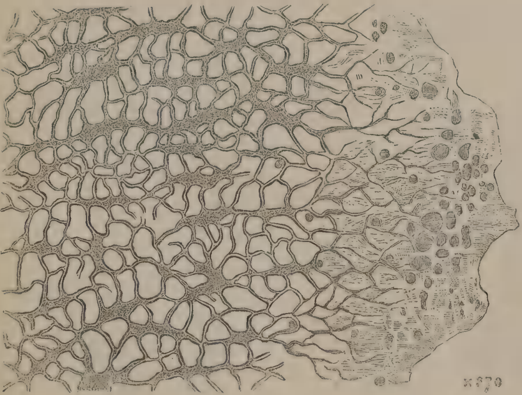
× 700

Fig. 40.

Fig. 41.

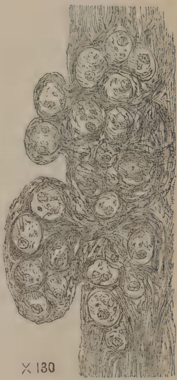
× 700

Fig. 43.



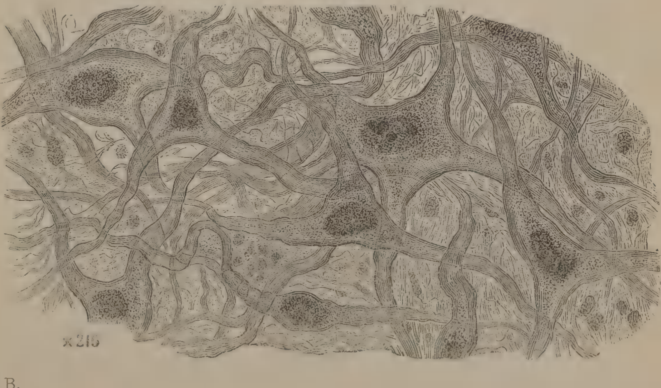
× 370

Fig. 42.



× 130

Fig. 44.



× 215

L. S. B.

Fig. 1.

Fig. 2.

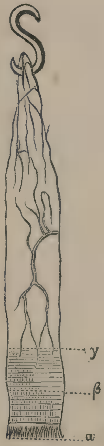


Fig. 3.

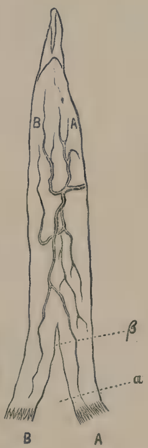


Fig. 4.

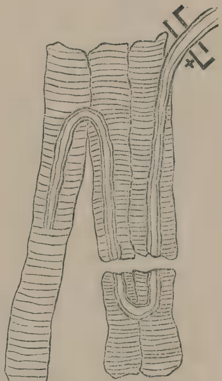


Fig. 5.

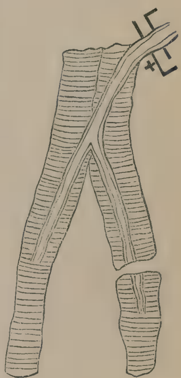


Fig. 6.

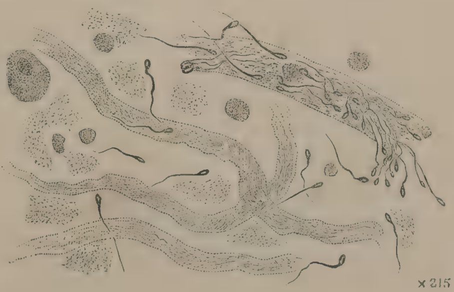


Fig. 1.

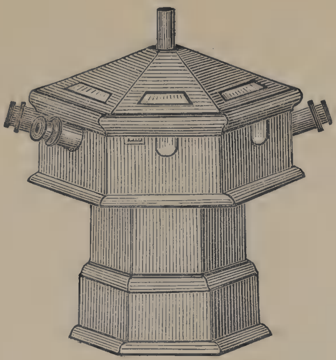


Fig. 2.

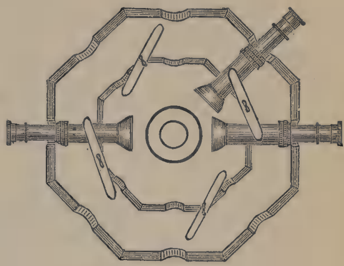


Fig. 3.

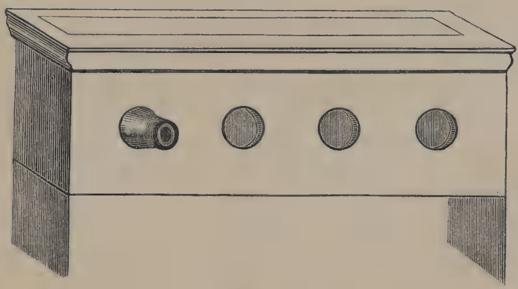


Fig. 5.

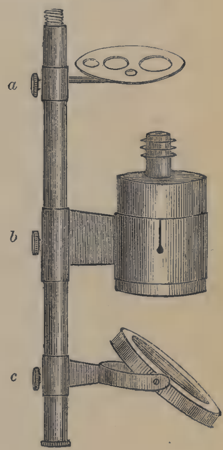


Fig. 4.

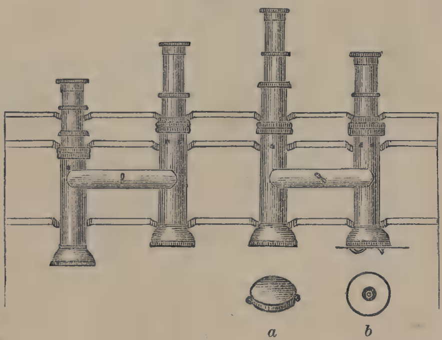
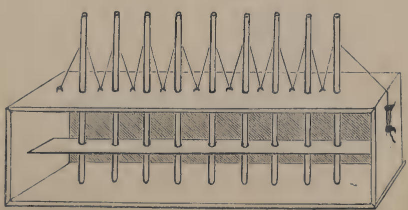


Fig. 6.



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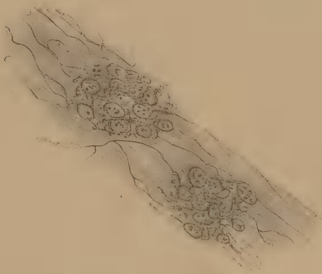
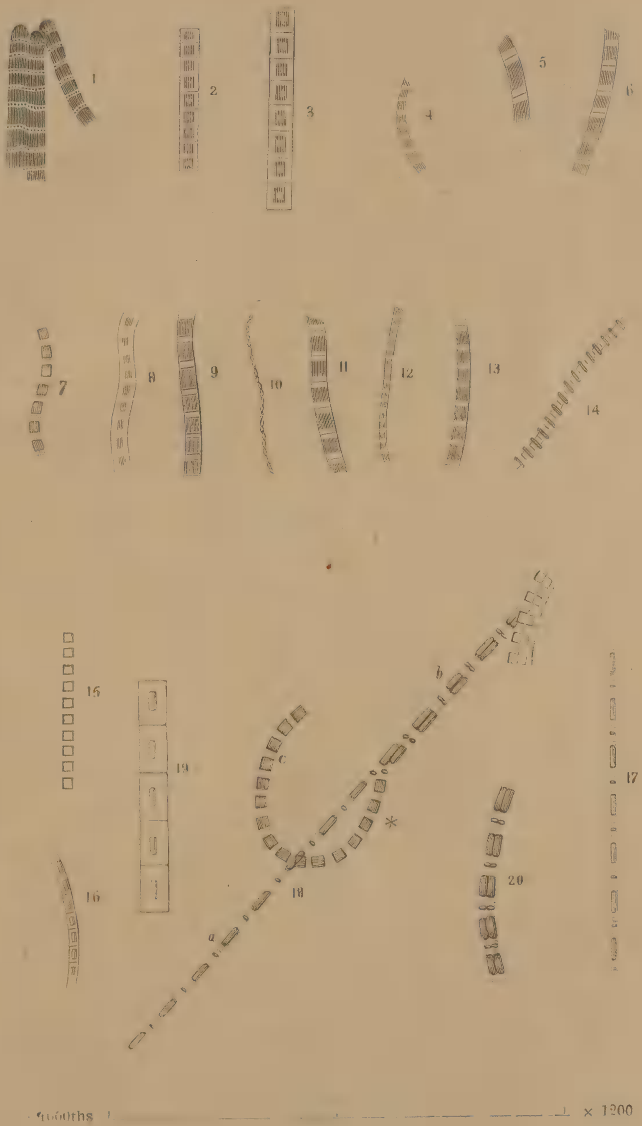
Tuffen West lith.

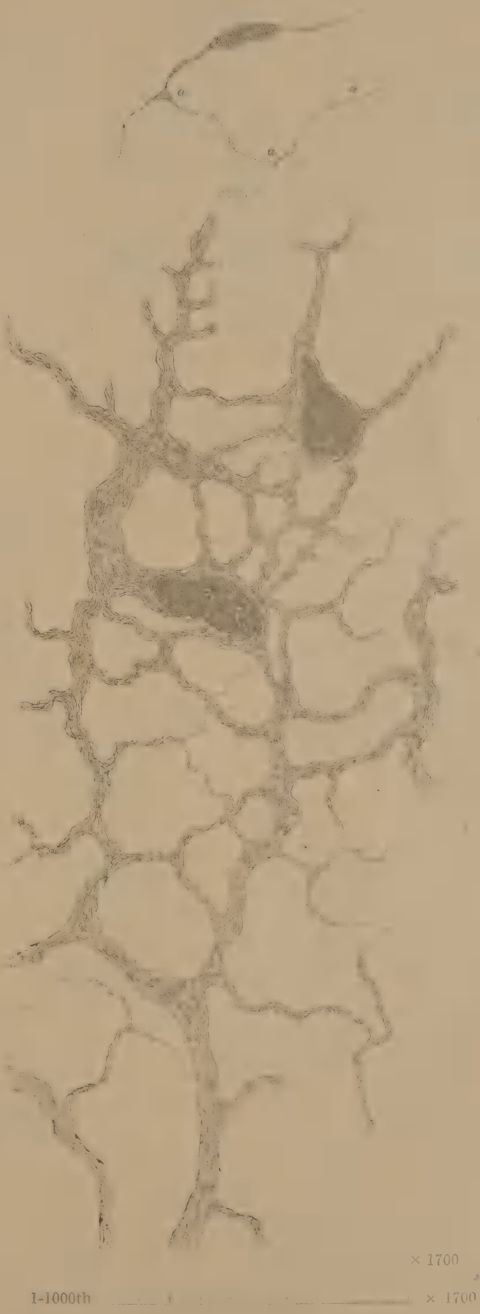


J. A. M. ad nat:



S. MARTYN, del.

ARCHIVES, 1862.

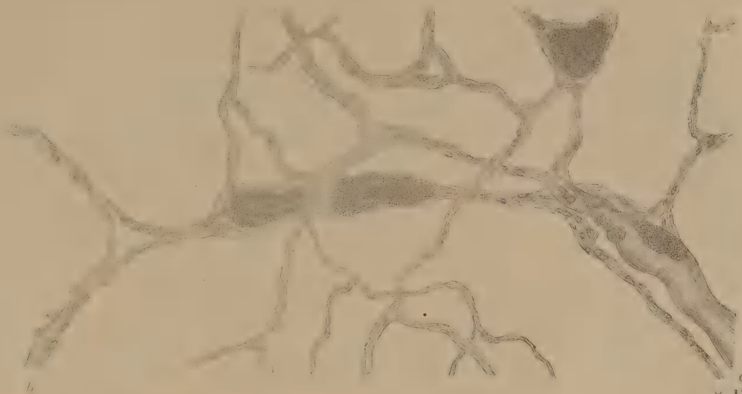


× 1700

1-1000th × 1700

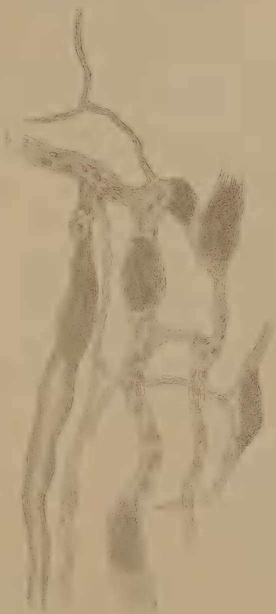
L. S. B. ad nat.

Fig. 3.



× 1700

Fig. 4.



× 1700

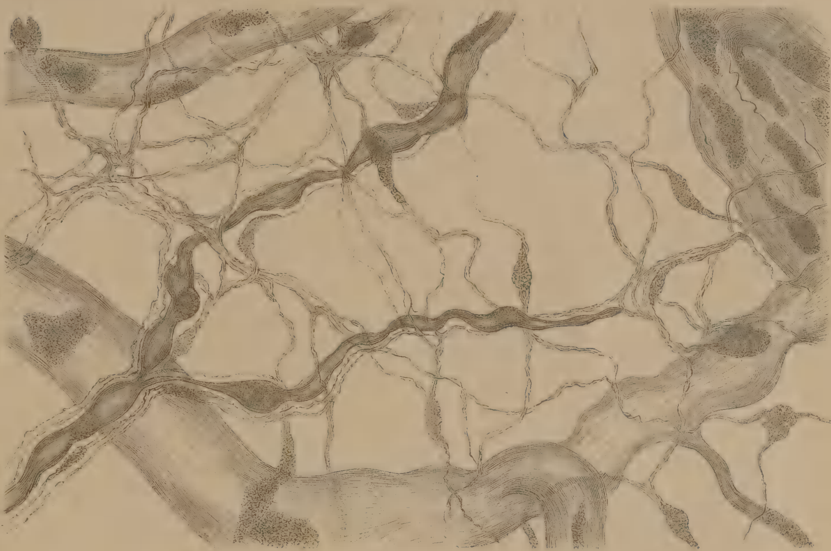
Fig. 5.

× 1700

1-1000th × 1700

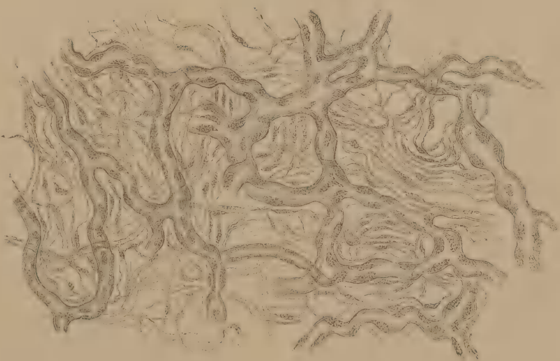
L. S. B. ad nat.

Fig. 6.



× 700

Fig. 7.

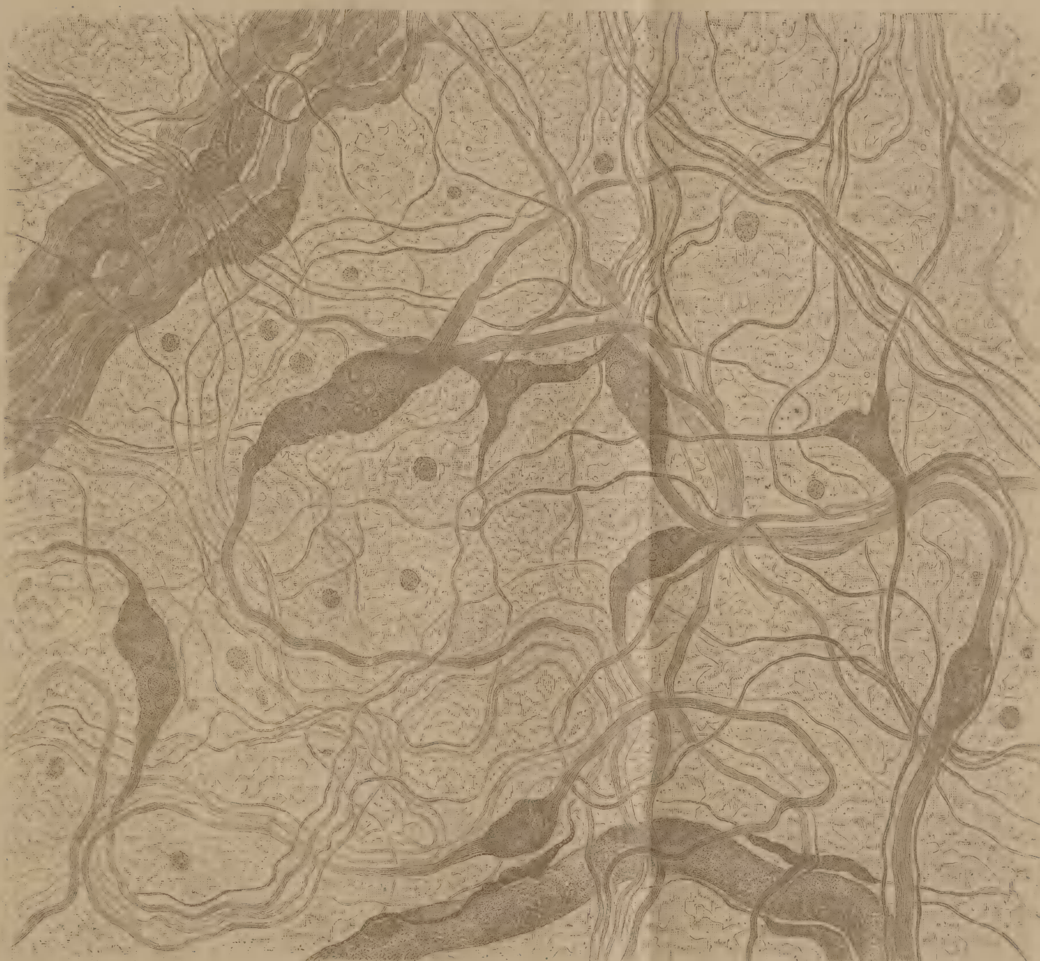


× 215

1000th × 700

1000th × 215

Fig. 8.



1-1000th × 1700

L. S. B. ad nat.

Fig. 9.

Fig. 10.

× 700

Fig. 11

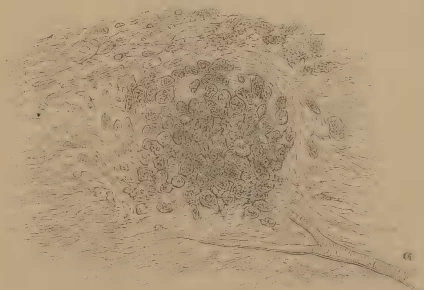
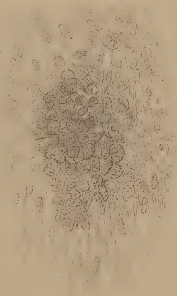


Fig. 12.



1000th × 700